PENNSYLVANIA 2002 AREA SOURCE CRITERIA AIR POLLUTANT EMISSION ESTIMATION METHODS

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AREA SOURCE DEFINITION

For emission inventory development purposes, the term "area sources" traditionally refers to stationary air pollutant emission sources that are not inventoried at the facility-level. While point sources are inventoried individually, area sources are typically inventoried at the county level (*Introduction to Area Source Emission Inventory Development Volume III: Chapter 1*).[1] Gasoline stations and dry cleaning establishments are often treated as both point and area sources. The main reason they are not exclusively treated as point sources is that the effort required to gather data and estimate emissions for each individual facility is very great, while emissions per facility are generally small. For these sources, a cut-off point, typically based on annual emissions, usually defines the distinction between point and area. The Consolidated Emissions Reporting Rule (CERR) specifies reporting criteria air pollutant (CAP) thresholds for point and area sources, which vary depending on the pollutant and the attainment status of a county (see http://www.epa.gov/ttn/chief/cerr/index.html).

Individual emissions sources are grouped with other like sources into source categories. These source categories are grouped in such a way that they can be estimated collectively using one methodology. Most area source categories do not have an analogue in the point source inventory. Pesticide use and commercial/consumer product use are such examples. The boundaries of the individual activities associated with these sources are often hard to determine or are, at best, arbitrary. Even within a point source facility, some activities occur that are more easily treated as area source emissions. Some emissions associated with surface coating operations such as equipment cleaning, for example, can be more practically estimated using area source methods even though other surface coating operations may be reported as part of the point source inventory.

METHODS FOR ESTIMATING AREA SOURCE ACTIVITY AND EMISSIONS

Area source emissions are generally estimated by multiplying an emission factor by some known indicator or collective activity for each area source category at the county level. Several methodologies are available for estimating area source activity levels and emissions. For this 2002 area source inventory, estimates were derived by (1) treating area sources as point sources, (2) obtaining county-level activity data, (3) apportioning national or statewide activity data to counties, (4) use of per capita emission factors, and (5) use of per employee emission factors. Each approach has distinct advantages and disadvantages as discussed below.

Small sources that would normally be treated as area sources may be handled as point sources for several reasons. First, county level activity data may not be readily determinable for certain source categories. Municipal landfills provide an example of this situation.

For some source categories, county activity estimates were available. For example, monthly wine production data for 2002 were available by county from the Pennsylvania Liquor Control Board. If county activity data were not available, Commonwealth totals were apportioned to counties using data for a surrogate of the emissions activity. For example, the quantity of

highway gasoline consumed in the Commonwealth was apportioned to the county level on the basis of vehicle miles traveled per county. Residential, commercial, and industrial fuel combustion were other categories that were handled in this manner. The major drawbacks of this approach are that additional data and resources are needed to apportion activity levels to the local level, and accuracy is lost in the process. If Commonwealth level data were not available, then national data were used in a similar manner.

Sources in certain area source categories were not only numerous and diffuse, but were too difficult to inventory by any of the above procedures. As an example, solvent evaporation from consumer and commercial products such as waxes, aerosol products and window cleaners cannot be routinely determined by DEP. In addition, it would be resource-intensive to develop and implement a survey that would yield such information. Per capita or per employee emission factors are used to estimate emissions for these source categories. The use of per capita emission factors is based on the assumption that, for a given source category, emission activity can be reasonably associated with population. This assumption is valid over broad areas for certain categories such as Architectural Surface Coating and solvent evaporation from Consumer and Commercial Products.

For categories that rely on a per capita emission factor, county population estimates for 2002 were obtained from the U.S. Bureau of the Census. When emissions are calculated from per employee emission factors, county-level employment data for 2002 were estimated from a combination of two sources. Because county employment data for 2002 will not be available from the Bureau of the Census' *County Business Patterns* (CBP) until April 2004, 2001 data for the appropriate North American Industrial Classification System (NAICS) codes were obtained from the 2001 CBP[2] and projected to 2002 using the Commonwealth-level 2001 to 2002 employment change for the appropriate NAICS codes. The Commonwealth-level employment data were obtained at the NAICS code level from the U.S. Bureau of Labor Statistics.[3]

In some cases, the Census does not report the employment value for a particular NAICS code/county combination because of confidentiality concerns. In these cases, the Census provides employment data as a range (e.g., between 20 and 99 employees). When a precise number of employees was not available from CBP, an initial estimate was developed based on the mid-point of the reported range (e.g., 60 employees was used for the 20 to 99 employment range). For a given NAICS code, the mid-point estimates were then adjusted up or down to yield the Commonwealth-level employment for that NAICS code as reported in the CBP. The adjustments were computed by first calculating the difference between the Commonwealth-level CBP employment and the total of the employment values for counties for which actual employment values were reported in the CBP. The resulting value represents employment for the counties for which the CBP reports an employment range value. This value was then divided by the sum of the mid-point employment estimates for the counties for which employment was reported as a range. The resulting ratio was multiplied by the mid-point estimates to yield the final county employment estimates. The calculation spreadsheets provide each of the steps used in this estimation procedure.

Control Efficiency (CE)

Control efficiency is the emission reduction percentage associated with a control device, process change or reformulation. Control efficiencies can vary widely by source within an area source category. Area source control efficiency values represent the weighted average control for the category.

Rule Penetration (RP)

Because lower-emitting sources within a source category may not be covered by a regulation, it is important to reflect the extent to which total source category emissions are affected. Rule penetration represents the percentage of total source category emissions that are affected by a regulation.

Rule Effectiveness (RE)

Rule effectiveness is a factor used to adjust the control efficiency to account for failures and uncertainties that affect the actual performance of the control. For example, control equipment performance may be adversely affected by age of the equipment, lack of maintenance, or improper use. With the exception of Federal regulations, a default RE value of 80 percent was applied when information was not available to substantiate the true RE value.[1] An RE of 100 percent was applied to all Federal regulations that require national compliance.

The RE factor is applied to the estimated control efficiency in the calculation of emissions from a source. The formula for the application of CE, RP, and RE is displayed below:

Uncontrolled Emissions	=	50 pounds per day
Control Efficiency	=	90 percent
Rule Penetration	=	60 percent
Rule Effectiveness	=	80 percent

Controlled Emissions = Uncontrolled Emissions × (1 – CE/100 × RP/100 × RE/100)

Controlled Emissions = 50 × (1 – 0.9 × 0.6 × 0.8) = 50 × (1 – 0.432) = 28.4 pounds per day

An RE and/or RP value can substantially increase emission estimates when high control efficiencies are involved. For example, if RP was not applied in the above example (equivalent to a 100 percent RP assumption), then estimated emissions are:

Controlled Emissions = 50 × (1 – 0.9 × 0.8) = 50 × (1 – 0.72) = 14 pounds per day.

Seasonal Emission Calculations

Area source emissions are typically prepared first on an annual basis because activity data are generally only available on an annual basis. The recently promulgated Consolidated Emissions

Reporting Rule (CERR) requires States to submit county-level area source CAP emission inventories to EPA for three temporal periods: annual, summer season work weekday, and winter season work weekday (the latter for carbon monoxide and particulate matter emissions only). Summer season work weekday emission inventories are needed to support planning for ozone NAAQS attainment. The summer season refers to the peak ozone season months of June, July, and August. Winter season work weekday emission inventories are used to support carbon monoxide (CO) NAAQS attainment planning. The winter season refers to January, February, and December of the same year (e.g., 2002).

Seasonal emission estimates are calculated by adjusting the annual inventory to reflect activity during the summer and winter season. Summer work weekday and winter work weekday emissions are calculated by multiplying annual emissions by the appropriate allocation factor. For most source categories, summer and winter work weekday allocation factors were developed from default monthly and weekly profiles available from EPA's Emissions Modeling ClearingHouse (EMCH).[4]

The EMCH provides 807 different monthly profiles and 45 different weekly profiles. The first step in developing summer allocation factors was to compute summer monthly ratios by dividing the sum of the June, July, and August monthly profile values by the total of the twelve monthly profile values. Winter monthly ratios were calculated in a similar manner, except monthly profile values for January, February, and December were incorporated into the calculation. Weekday profile values were computed by dividing the sum of the Monday through Friday weekly profile values by the total profile value for the entire week.

Summer work weekday allocation factors were calculated by multiplying the summer monthly ratios by the appropriate weekday ratio and then dividing the result by 65 (the number of work weekdays in the summer of 2002). In a like manner, winter work weekday allocation factors were computed by multiplying winter monthly ratios by the appropriate weekday ratio and dividing by 65 (the number of work weekdays in the winter of 2002).

These allocation factors were then matched to area source classification codes (SCCs) via a crosswalk between SCCs and temporal profiles available from EPA's EMCH. Annual emissions for each SCC/county/pollutant combination were then multiplied by the appropriate summer work weekday allocation factor to yield summer work weekday emissions. Winter work weekday emissions were calculated for categories emitting CO and/or PM. Similar to the summer calculations, annual CO and PM emissions were multiplied by the appropriate winter work weekday allocation factor to yield winter work weekday emissions.

For source categories for which actual monthly/seasonal activity data were available (e.g., Residential Natural Gas Combustion, Structure Fires, and Wineries), summer and winter season allocation factors were calculated from the available activity data. The following presents sample calculations performed to develop the summer work weekday allocation factor for Bakeries. The individual source category methodology sections present the calculations performed to compute each category's seasonal emission estimates.

SAMPLE CALCULATION OF SUMMER SEASON WORK WEEKDAY ALLOCATION FACTOR:

Bakeries (SCC 2302050000)

$$Summer\ Season\ Ratio = \frac{(\text{June Profile Value} + \text{July Profile Value} + \text{August Profile Value})}{\text{Total of Monthly Profile Values}}$$

$$= \frac{83 + 83 + 83}{996} = 0.25$$

$$Weekday\ Ratio = \frac{Sum\ of\ Monday\ through\ Friday\ Profile\ Values}{Sum\ of\ Weekly\ Values}$$

$$= \frac{143 + 143 + 143 + 143 + 143}{1000} = 0.715$$

Summer Work Weekday Allocation Factor = 0.25 × 0.715 ÷ 65 = 0.00275

For source categories for which actual seasonal emissions activity data were available (e.g., Residential Natural Gas Combustion, Structure Fires, and Wineries), the summer and winter season allocation factors were developed from these activity data.

Point Source Subtractions

Source categories can appear in both the area source and point source inventory. For example, emissions from large dry cleaning establishments may be included in the point source inventory, while emissions from smaller dry cleaners (below some specified cutoff) are included in the area source inventory. When a point source inventory and an area source inventory include emissions from the same process, the area source emission estimates are adjusted to avoid double-counting. Although many area source categories (e.g., Architectural Surface Coating) do not have companion point source categories, there are many source categories in the area source inventory for which emissions are reported in the Pennsylvania point source inventory (see Table 1). For these source categories, point source emissions are subtracted from total emission estimates to yield area source emissions. Ideally, this adjustment would occur in the area source emission calculation by subtracting point source emission activity (throughput) from total emission activity as shown below.

$$Area\ Source\ Activity = (Total\ Activity) - (Point\ Source\ Activity)$$

However, the Pennsylvania point source inventory does not report throughput for most sources. Therefore, it was necessary to calculate the point source subtractions using total and point source emission estimates as identified below.

$$Area\ Emissions_{p} = (Total\ Emissions_{p}) - (Point\ Source\ Emissions_{p})$$

where:

p = pollutant

Separate point source inventories were developed for Allegheny and Philadelphia counties and for all other counties. Except for ammonia and lead, the Allegheny inventory reports annual emissions for all pollutants included in the area source inventory. These pollutants are also missing from the Philadelphia County annual inventory. Unlike the Allegheny inventory, the Philadelphia County inventory does not report PM emissions on a filterable and condensable basis, but rather on a primary basis. The inventory for the remaining counties reports annual emissions for the same pollutants as the Philadelphia County inventory, with the exception of primary $PM_{2.5}$ (PM25-PRI), which is not reported for the remaining counties. Given the different ways in which PM emissions are reported in the 2002 Pennsylvania point source inventory, it was necessary to develop PM emissions on a consistent basis to facilitate the point source subtractions. Therefore, for Allegheny County, Pechan summed the condensable and the filterable PM emissions to obtain PM10-PRI and PM25-PRI emission values for use in the point source subtractions.

Although the point source inventories also report winter and summer day emissions, these estimates were not used in the point source subtractions. The annual emission estimates were used in the subtractions because it is not clear if every point source facility that would have emissions during the summer/winter have these emissions reported in the inventory. For example, there are only 14 records with winter day NO_x emissions in the point source inventory, while there are over 4,000 records with annual NO_x emissions reported in the inventory.

To facilitate the point source subtractions, the annual emission records for all point SCCs associated with an area source category were summed to the county level. Because PA DEP indicated that point source subtractions should be applied to the Machinery and Equipment Solvent Coating area source category by subtracting point source emission records associated with the combination of point SCCs 40202501, 40202502, and 40202599 and SIC code 3531, it was also necessary to compile county level annual emissions for these records. In addition, because these point SCCs are also associated with the Miscellaneous Finished Metals Surface Coating area source category, it was necessary to compile county-level annual emissions for all point source records with these SCCs that are not associated with SIC code 3531.

The county-level point source annual emissions were then subtracted from the area source category annual emissions using an area source category-to-point source category crosswalk developed for this project. Note that in keeping with EIIP guidance, when the resulting area source emission estimate was negative, the area source emission value was set to zero. In addition, when the PM10-PRI emission estimate resulted in a zero value, then the companion PM25-PRI emission estimate was set to zero for consistency. In addition to setting PM25-PRI emissions to zero when PM10-PRI emissions were zero, we also set PM25-PRI emissions to PM10-PRI emissions when PM25-PRI emissions were greater than PM10-PRI emissions, after the point source subtractions were performed. Finally, the summer and winter season work

weekday emission estimates were updated by multiplying the revised annual emission estimate by the appropriate winter season and/or summer season work weekday allocation factors. The following presents sample point source NO_x emission subtraction calculations for the Commercial/Institutional Bituminous/Subbituminous Coal Combustion category (SCC 2103002000).

$$Area\,Source\,NOx\,Emissions\,for\,SCC\,2103002000 = (Total\,NOx\,Emissions) - (Point\,NOx\,Emissions)$$

$$Total\,NOx\,Emissions\,for\,SCC\,2103002000\,(AlleghenyCnty) = 1{,}054.3025\ tons\ \ per\,year$$

$$Point\,Source\,NOx\,Emissions(AlleghenyCnty) = 152.0751 tons\ (SCC\,10300207) + 6.2277 tons\ (SCC\,10300208)$$

$$Area\,Source\,NOx\,Emissions\,for\,SCC\,2103002000 = (1{,}054.3025\,tons) - (158.3028\,tons)$$
$$= 895.9997\,tons$$

The following individual sections describe the annual and seasonal emission estimation methodology for each area source category. Each section contains a brief description of the source category, identifies whether the category's emission estimates were subject to point source emission subtractions, and presents sample emission calculations (point source subtractions are not included in these sample calculations). All referenced sources are displayed in Appendix A.

Table 1. Area Source Inventory Categories with Point Source Emission Subtractions

SCC	SCC1DESC	SCC3DESC	SCC6DESC	SCC8DESC
2102001000	Stationary Source Fuel Combustion	Industrial	Anthracite Coal	Total: All Boiler Types
2102002000	Stationary Source Fuel Combustion	Industrial	Bituminous/Subbituminous Coal	Total: All Boiler Types
2103001000	Stationary Source Fuel Combustion	Commercial/Institutional	Anthracite Coal	Total: All Boiler Types
2103002000	Stationary Source Fuel Combustion	Commercial/Institutional	Bituminous/Subbituminous Coal	Total: All Boiler Types
2103004000	Stationary Source Fuel Combustion	Commercial/Institutional	Distillate Oil	Total: Boilers and IC Engines
2103005000	Stationary Source Fuel Combustion	Commercial/Institutional	Residual Oil	Total: All Boiler Types
2103006000	Stationary Source Fuel Combustion	Commercial/Institutional	Natural Gas	Total: Boilers and IC Engines
2103007000	Stationary Source Fuel Combustion	Commercial/Institutional	Liquefied Petroleum Gas (LPG)	Total: All Combustor Types
2302050000	Industrial Processes	Food and Kindred Products: SIC 20	Bakery Products	Total
2302070001	Industrial Processes	Food and Kindred Products: SIC 20	Fermentation/Beverages	Breweries
2401015000	Solvent Utilization	Surface Coating	Factory Finished Wood: SIC 2426 thru 242	Total: All Solvent Types
2401020000	Solvent Utilization	Surface Coating	Wood Furniture: SIC 25	Total: All Solvent Types
2401025000	Solvent Utilization	Surface Coating	Metal Furniture: SIC 25	Total: All Solvent Types
2401040000	Solvent Utilization	Surface Coating	Metal Cans: SIC 341	Total: All Solvent Types
2401050000	Solvent Utilization	Surface Coating	Miscellaneous Finished Metals: SIC 34 - (341 + 3498)	Total: All Solvent Types
2401055000	Solvent Utilization	Surface Coating	Machinery and Equipment: SIC 35	Total: All Solvent Types
2401060000	Solvent Utilization	Surface Coating	Large Appliances: SIC 363	Total: All Solvent Types
2401070000	Solvent Utilization	Surface Coating	Motor Vehicles: SIC 371	Total: All Solvent Types
2401080000	Solvent Utilization	Surface Coating	Marine: SIC 373	Total: All Solvent Types
2401085000	Solvent Utilization	Surface Coating	Railroad: SIC 374	Total: All Solvent Types
2401090000	Solvent Utilization	Surface Coating	Miscellaneous Manufacturing	Total: All Solvent Types
2415200000	Solvent Utilization	Degreasing	All Industries: Conveyerized Degreasing	Total: All Solvent Types
2415300000	Solvent Utilization	Degreasing	All Industries: Cold Cleaning	Total: All Solvent Types
2420000370	Solvent Utilization	Dry Cleaning	All Processes	Special Naphthas
2425000000	Solvent Utilization	Graphic Arts	All Processes	Total: All Solvent Types
2501060053	Storage and Transport	Petroleum and Petroleum Product Storage	Gasoline Service Stations	Stage 1: Balanced Submerged Filling
2501060101	Storage and Transport	Petroleum and Petroleum Product Storage	Gasoline Service Stations	Stage 2: Displacement Loss/Uncontrolled
2501060102	Storage and Transport	Petroleum and Petroleum Product Storage	Gasoline Service Stations	Stage 2: Displacement Loss/Controlled
2601010000	Waste Disposal, Treatment, and Recovery	On-site Incineration	Industrial	Total
2601020000	Waste Disposal, Treatment, and Recovery	On-site Incineration	Commercial/Institutional	Total
2620030000	Waste Disposal, Treatment, and Recovery	Landfills	Municipal	Total
2630020010	Waste Disposal, Treatment, and Recovery	Landfills	Wastewater Treatment Processes	Total

AGRICULTURAL PRODUCTION – ANIMAL HUSBANDRY

Emissions from livestock production come from such activities as confinement, manure handling and storage, and land application of manure. Biogenic emission source calculations were derived from EPA's BEIS inventory system.

AGRICULTURAL PRODUCTION – CROPS (Fertilizer Application) (14 SCCs)

(Anhydrous Ammonia SCC 2801700001, Aqueous Ammonia SCC 2801700002, Nitrogen Solutions SCC 2801700003, Urea SCC 2801700004, Ammonium Nitrate SCC 2801700005, Ammonium Sulfate SCC 2801700006, Ammonium Thiosulfate SCC 2801700007, N-P-K (multi-grade nutrient fertilizers) SCC 2801700010, Calcium Ammonium Nitrate SCC 2801700011, Potassium Nitrate SCC 2801700012, Diammonium Phosphate SCC 2801700013, Monoammonium Phosphate SCC 2801700014, Liquid Ammonium Polyphosphate SCC 2801700015, Misc. Fertilizers SCC 2801700099)

Emissions from crops are primarily due to spreading of various fertilizers. Fertilizers spread on fields that contribute to ammonia emissions include anhydrous ammonia, aqueous ammonia, nitrogen solutions, urea, ammonium nitrate, calcium ammonia, and ammonium sulfate. Biogenic emission source calculations were derived from EPA's BEIS inventory system.

ARCHITECTURAL SURFACE COATING (SCC 2401001000)

Architectural surface coatings are used by homeowners and painting contractors to coat the interior and exterior of buildings and other structures. The coatings are applied by spray, brush, or roller and dry or cure at ambient conditions. The VOC emissions from this source category result from the evaporation of the paint and cleanup solvents. Each county's emissions are calculated using a per capita emission factor and U.S. Bureau of the Census 2002 population data. The Federal architectural surface coating regulations call for a 20 percent reduction in the solvent content of architectural surface coatings manufactured after September 1999.[5] Therefore, a 20 percent CE is applied in the 2002 inventory.

The emission factor that is used in this effort differs from that used for the 1999 area source inventory. The new per capita emission factor was calculated using the Emission Inventory Improvement Program (EIIP) methods for this category. National solvent- and water-based coating per capita use factors were first calculated from 2002 national paint shipments[6] and 2002 national population data.[7] These factors were then combined with information on the average volatile organic compound (VOC) content of these coatings to calculate per capita emission factors as follows:

Water-Based = 0.74 pounds VOC/gallon[8] × 589,527,000 gallons[6] /288,368,698 people[7]
= 1.5128 pounds VOC/person/year

Solvent-Based = 3.87 pounds VOC/gallon[8] × 119,914,000 gallons[6] /288,368,698 people[7]
= 1.6093 pounds VOC/person/year

Final composite emission factor = 1.5128 + 1.6093 = 3.1221 pounds VOC/person/year

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\ VOC\ Emissions = (EmissionFactor)(Population)\left(1 - \frac{CE}{100} \cdot \frac{RP}{100} \cdot \frac{RE}{100}\right)$$

where:

Emission Factor = 3.1221 *lbs VOC/person/year*
Population = 1,269,904 (Allegheny County)[7]
CE (Control Efficiency) = 20%[5]
RP (Rule Penetration) = 100%
RE (Rule Effectiveness) = 100%

$$Annual\ VOC\ Emissions = \left(\frac{3.1221 lbs VOC / person}{year}\right)(1{,}269{,}904\ people)\left(1 - \frac{20}{100} \cdot \frac{100}{100} \cdot \frac{100}{100}\right)$$

$$Annual\ VOC\ Emissions = 3{,}171{,}813.823\ pounds\ per\ year \cdot \left(\frac{1\ ton}{2000\ lbs}\right) = 1585.9069\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00356 [9]
Summer work weekday VOC emissions = 1585.9069 × 0.00356 = 5.6484 tons VOC per day

ASPHALT PAVING (2 SCCs)

There are two types of asphalt used for road paving and repair: cutback asphalt and emulsified asphalt. VOC emissions result primarily from the curing of the applied material. The following sections describe the two types of asphalt and identify the methods used to estimate emissions for each type.

Cutback Asphalt (SCC 2461021000)

Cutback asphalt is used as a pavement sealant, a tack coat, and a bonding agent between layers of paving material. Cutback asphalt is prepared by blending or "cutting back" asphalt cement with various blends of petroleum distillates. Emissions from cutback asphalt paving occur during the curing of the road surface when petroleum distillates evaporate.

Annual VOC emissions from cutback asphalt paving were computed from information obtained from the Pennsylvania Association of Asphalt Material Applicators (PAMA) on the amount of

cutback asphalt applied in 2002 and the VOC content and density of the asphalt.[10] In addition, it was assumed that 100 percent of cutback asphalt contained diluent and that 70 percent of the diluent evaporates.[11] County emissions were estimated by multiplying State emissions by the ratio of the each county's bituminous paved lane mileage by the State's bituminous paved lane mileage.[12] Based on the State regulation prohibiting use of cutback asphalt during summer months, there are no summer season work weekday emissions estimated for cutback asphalt.[13]

Emulsified Asphalt (SCC 2461022000)

Emulsified asphalt is a type of liquefied road surfacing material that is used in some of the same applications as cutback asphalt. However, instead of blending asphalt cement with petroleum distillates, emulsified asphalt uses a blend of water with an emulsifier.

Annual VOC emissions from emulsified asphalt paving were computed from information obtained from the Pennsylvania Association of Asphalt Material Applicators on the amount of emulsified asphalt applied in 2002, the VOC content and density of the asphalt, and the percentage of emulsified asphalt containing diluent.[10] In addition, it was assumed that 100 percent of the emulsified asphalt diluent evaporates.[11] County emissions were estimated by multiplying State emissions by the ratio of the each county's bituminous paved lane mileage by the State's bituminous paved lane mileage.[14] Annual emissions were allocated to the summer season work weekday based on information from PAMA that emulsified asphalt is only applied from March 1 through October 31.[15] In addition, it was assumed that asphalt use is evenly distributed during this period and that paving is only performed on weekdays.

SAMPLE VOC EMISSION CALCULATIONS:

$$Emission\ \ Factor = (VOC\ \ Content)(VOC\ \ Density)$$

$$Statewide\ Annual\ Emissions = (Emission\ \ Factor)(2002\ \ State\ Asphalt\ \ Use)(\%\ \ of\ \ Diluent\ \ Evaporating)$$

$$County\ \ Annual\ VOCEmissions = Statewide\ VOC\ \ emissions\ x\ \frac{County\ \ Bituminous\ Paved\ \ Lane\ \ Miles}{State\ \ Bituminous\ Paved\ \ Lane\ \ Miles}$$

where:

Cutback Asphalt VOC Content = 35%[10]
Emulsified Asphalt VOC Content = 8%[10]
Cutback Asphalt VOC Density = 7.1 lbs/gallon[10]
Emulsified Asphalt VOC Density = 6.25 lbs/gallon[10]
2002 PA Cutback Asphalt Use = 5,000,000 gallons[10]
2002 PA Emulsified Asphalt Use = 15,000,000 gallons[10]
Bituminous Paved County Lane Miles = 2,538 miles (Allegheny)[14]
Bituminous Paved State Lane Miles = 83,227 miles[14]
% of Cutback Asphalt Diluent that Evaporates = 70%[11]
% of Emulsified Asphalt Containing Diluent = 50%[10]
% of Emulsified Asphalt Diluent that Evaporates = 100%[11]

Cutback Asphalt VOC Emissions Calculation:

$$Emission\ Factor = 0.35 \cdot \frac{7.1\ lbs\ VOC \big/ gallon}{year} \cdot \frac{1\ ton}{2000\ lbs} = 0.0012425\ tons\ VOC\ per\ gallon\ per\ year$$

$$Annual\ VOC\ Emissions = \frac{0.0012425\ tons\ VOC \big/ gallon}{year} \cdot 5\ million\ gallons\ cutback\ asphalt \cdot 0.7 \cdot \frac{2{,}538\ miles}{83{,}227\ miles}$$

$$Annual\ VOC\ Emissions = 132.6147\ tons\ VOC\ per\ year$$

(Summer work weekday emissions are estimated as zero due to State prohibition on use during this period)[13]

Emulsified Asphalt VOC Emissions Calculation:

$$Emission\ Factor = 0.08 \cdot \frac{6.25\ lbs\ VOC \big/ gallon}{year} \cdot \frac{1\ ton}{2000\ lbs} = 0.00025\ tons\ VOC\ per\ gallon\ per\ year$$

$$Annual\ VOC\ Emissions = \frac{0.00025\ tons\ VOC \big/ gallon}{year} \cdot 15\ million\ gallons\ emulsified\ asphalt \cdot 0.5 \cdot \frac{2{,}538\ miles}{83{,}227\ miles}$$

$$Annual\ VOC\ Emissions = 57.1780\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 3/8 (fraction of paving performed in the summer months) × 5/7 (fraction of paving performed on weekdays) ÷ 65 (number of weekdays in the summer) = 0.004125[15]
Summer work weekday VOC emissions = 57.1780 × 0.004125 = 0.2359 tons VOC per day

AUTOMOTIVE REFINISHING (SCC 2401005000)

Automotive refinishing is the painting of worn or damaged automobiles, light trucks, and other vehicles. The coating of new cars, however, is considered in the point source inventory, and therefore not included in this inventory. The automotive refinishing VOC emission factor of 2.30 lb/person is based on EPA guidance.[16] A control efficiency of 60.94 percent for 2002 was computed by applying an incremental reduction of 38 percent[17] to 1999's 37 percent[18] control efficiency based on the following calculation:

$$2002\ Control\ Efficiency = \left(1 - \left(1 - \frac{Incremental\ 2002\ Control\ Efficiency}{100}\right)\left(1 - \frac{1999\ Control\ Efficiency}{100}\right)\right) \cdot 100$$

$$2002\ Control\ Efficiency = \left(1 - \left(1 - \frac{38}{100}\right)\left(1 - \frac{37}{100}\right)\right) \cdot 100 = 60.94\%\ Control\ Efficiency$$

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\,VOC\,Emissions = (Emission\ \ Factor)(\ Population\ )\left(1-\frac{CE}{100}\cdot\frac{RP}{100}\cdot\frac{RE}{100}\right)$$

where:

Emission Factor =2.30 lbs VOC/person/year[16]
Population = 1,269,904 (Allegheny County)[7]
Control Efficiency = 60.94%[17] [18]
Rule Penetration = 100%
Rule Effectiveness = 100%

$$Annual\ VOC\ Emissions = \left(\frac{2.30\ lbsVOC\,/\,person}{year}\right)(1{,}269{,}904\ people)\left(1-\frac{60.94}{100}\cdot\frac{100}{100}\cdot\frac{100}{100}\right)$$

$$Annual\ VOC\ Emissions = 1{,}140{,}856\ pounds\ per\ year\cdot\frac{1\ ton}{2000\ lbs} = 570.4282\ tons\ VOC\ \ per\ \ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00385 [9]
Summer work weekday VOC emissions = 570.4282 × 0.00385 = 2.1940 tons VOC per day

BAKERIES (SCC 2302050000)

Bakery emissions, primarily ethanol, result from yeast fermentation during the baking process of bread and bakery products. Ethanol is emitted through a vent with any combustion product gases. Relevant NAICS codes for bakeries are 311811 and 311812.

County-level VOC emissions were calculated using an employment-based emission factor and the number of NAICS code 311811 and 311812 employees in each county. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] The Bakeries emission factor is 0.11 tons VOC/employee/year**.**[19] Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Employees)

where:

Emission Factor = 0.11 tons VOC /employee/year[19]
Employees = 1024 [2] [3] *(Allegheny County)*

$$Annual\ VOC\ Emissions = \left(\frac{0.11\ tons\ VOC / employee}{year} \right) (1024\ employees) = 112.64\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor=0.00275[4]
Summer work weekday VOC emissions = 112.64×0.00275 = 0.3098 tons VOC per day

BREWERIES (SCC 2302070001)

Emissions of VOCs from breweries result from compounds such as ethanol, myrcene, ethyl acetate and higher alcohols resulting from the brewing process. There are two brewery emission factors, which differ based on facility production size (i.e., a smaller emission factor is used for facilities with more than 60,000 barrels production, and a larger factor for facilities producing 60,000 barrels or less).

Because facility-level brewery production data were not available, it was necessary to estimate the amount of production in each county associated with small and large facilities. First, county-level beer production was estimated by apportioning State-level production to counties based on county-level brewery employment. Total Pennsylvania beer production was obtained from the Federal Alcohol and Tobacco Tax and Trade Bureau.[20] The number of brewery (NAICS code 31212) employees in 2002 was estimated by projecting 2001 county employment, obtained from the 2001 *County Business Patterns,*[2] to 2002 based on the 2002 to 2001 State-level brewery employment ratio, obtained from the Bureau of Labor Statistics.[3]

Based on the average Pennsylvania brewery production per employee (2,122 barrels) calculated from the data described above, it was assumed that all facilities in a county reporting fewer than 29 employees would contain only small breweries. The cutoff of 29 employees was chosen based on the observation that, assuming a constant per employee production rate, a brewery with 29 employees would produce approximately 61,500 barrels of beer. It was also assumed that a county with more than 29 brewery employees would have production by both small and large facilities. In lieu of actual data, it was assumed that 1 percent of these counties' production is from small breweries, and 99 percent is from large breweries. Therefore, the small brewery emission factor was applied to 1 percent of the county's beer production, while the large brewery emission factor was applied to 99 percent of the county's production. This 1 percent assumption appears reasonable given that this value results in statewide brewery emissions similar to those estimated for 1996.

Since Pennsylvania's brewery production data were available on a monthly basis, the statewide summer month allocation factor was calculated using the ratio of summer beer production to the annual beer production. This was then converted to the summer work weekday allocation factor using weekday temporal allocation data from EPA's Emissions Modeling Clearinghouse (EMCH).[4 20]

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\ VOC\ Emissions = (EmissionFactor)(Statewide\ Production)\left(\frac{County\ Employees}{State\ Employees}\right)$$

where:

Small Brewery Emission Factor = 56.743 pounds of VOC/1000 barrels[21]
Large Brewery Emission Factor = 4.16791 pounds of VOC/1000 barrels[22]
Adams County Employees = 7[2 3]
Allegheny County Employees = 261[2 3]
2002 PA Beer Production = 3,089,646 barrels[20]

Adams County (Small Breweries Only Assumption) Annual VOC Emissions:

$$Annual\ VOC\ Emissions = \frac{56.743\ lbs\ VOC}{1000\ barrels} \cdot 3{,}089{,}646\ barrels \cdot \frac{7\ County\ Employees}{1{,}456\ State\ Employees}$$

$$Annual\ VOC\ Emissions = 842.8634\ lbs\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 0.4214\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month beer production/annual beer production × weekday ratio/number of weekdays in summer
Summer work weekday allocation factor = 856,549/3,089,646 × 0.715/65 = 0.00305[4 20]
Summer work weekday allocation factor=0.00305
Summer work weekday VOC emissions = 0.4214 × 0.00305 = 0.001285 tons VOC per day

Allegheny County (Small and Large Breweries Assumption) Annual VOC Emissions:

$$Annual\ VOC\ Emissions = 0.01 \cdot \left(\frac{56.743\ lbs\ VOC}{1000\ barrels} \cdot 3{,}089{,}646\ barrels \cdot \frac{261\ County\ Employees}{1{,}456\ State\ Employees}\right) +$$
$$0.99 \cdot \left(\frac{4.168\ lbs\ VOC}{1000\ barrels} \cdot 3{,}089{,}646\ barrels \cdot \frac{261\ County\ Employees}{1{,}456\ State\ Employees}\right)$$

$$Annual\ VOC\ Emissions = 2599.5583\ lbs\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 1.2998\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month beer production/annual beer production × weekday ratio/number of weekdays in summer
Summer work weekday allocation factor = 856,549/3,089,646 × 0.715/65 = 0.00305[4 20]
Summer work weekday allocation factor=0.00305
Summer work weekday VOC emissions = 1.2998 × 0.00305 = 0.00396 tons VOC per day

COAL COMBUSTION (6 SCCs)

(Residential Anthracite SCC 2104001000, Residential Bituminous SCC 2104002000, Commercial/Institutional Anthracite SCC 2103001000, Commercial/Institutional Bituminous SCC 2103002000, Industrial Anthracite SCC 2102001000, Industrial Bituminous SCC 2102002000)

This category covers emissions from the burning of coal by residential, and small commercial and industrial users. Coal combustion emissions were estimated for VOC, NO_x, CO, Pb, PM, and SO_2.

Residential coal consumption, in tons per dwelling unit, was estimated using the following equation:

$$\textit{Coal consumption per dwelling unit} = 0.003874\, e^{(7.6414-(1000/\textit{heating degree days}))}$$

Heating Degree Day (HDD) data were obtained from the National Oceanic and Atmospheric Administration.[23] The HDD of each county was assigned according to the town or city in the county or the nearest town or city of similar latitude for which data were available.
After estimating county-level residential coal consumption per unit, emissions were calculated by multiplying these values by the number of coal-burning dwelling units in each county[24] and the emission factor for each pollutant.

Year 2002 Commonwealth-level commercial sector coal consumption (computed from the Energy Information Administration's *State Energy Data 2000*[25] and *Annual Coal Report 2002*[26]) was allocated to individual counties using the number of commercial sector facilities in each county.[2] County-level emissions were then calculated by multiplying county coal consumption by the emission factor for the applicable CAP.

Industrial coal-burning emissions were computed in a similar way to commercial/institutional emissions. However, county-level industrial employment data (from *County Business Patterns* and *Current Employment Statistics*) were used to allocate coal consumption to individual counties.

In some cases, CAP emission factors differ between anthracite and bituminous coal. Because anthracite is mined in the eastern half of the Commonwealth, while bituminous is mined in the western half, the emission calculations assume that eastern counties burn anthracite coal while western counties burn bituminous coal.

For Commercial and Industrial sector categories, point source emissions, where present, were subtracted from these initial emission estimates.

SAMPLE CALCULATIONS:

Residential Coal Combustion:

$$Annual\ Emissions = (Pollutant\ Emission\ Factor)(Percent\ Ash\ Content, if\ applicable)\cdot (Number\ of\ Coal\text{-}Burning\ Dwelling\ Units)\left(0.003874e^{\left(7.6414-\frac{1000}{HDD}\right)} \Big/ Coal\text{-}Burning\ Dwelling\ Units\right)$$

where:

VOC Emission Factor = 10 lbs/ton anthracite coal/year[27]; 10 lbs/ton bituminous coal/year[39]

NO_x Emission Factor = 3 lbs/ton anthracite coal/year[27]; 9.1 lbs/ton bituminous coal/year[39]

CO Emission Factor = 275 lbs/ton anthracite coal/year[27]; 275 lbs/ton bituminous coal/year[39]

Pb Emission Factor = 0.013182 lbs/ton bituminous coal/year[39]

PM10-FIL Emission Factor = 10 lbs/ton anthracite coal/year[27]; 6.2 lbs/ton bituminous coal/year[39]

PM25-FIL Emission Factor = 0.6 lbs/ton anthracite coal/year[27] × 13.38% ash content =8.028 lbs/ton anthracite coal/year; 3.8 lbs/ton bituminous coal/year[39]

PM-CON Emission Factor = 0.08 lbs/ton anthracite coal/year[27] × 13.38% ash content =1.0704 lbs/ton anthracite coal/year; 1.04 lbs/ton bituminous coal/year[39]

SO_2 Emission Factor = 39 lbs/ton anthracite coal/year[27] × 0.89% sulfur content =34.71 lbs/ton anthracite coal/year; 31 lbs/ton bituminous coal/year[39] × 2.42% sulfur content = 75.02 lbs/ton bituminous coal/year

Anthracite Coal Sulfur Content = 0.89% sulfur[27]

Bituminous Coal Sulfur Content = 2.42% sulfur[27]

Anthracite Coal Ash Content = 13.38% ash[27]

Number of Coal-Burning Dwelling Units (Allegheny County) = 183[24]

e = natural base

HDD = Heating Degree Days (Allegheny County) = 5,494[23]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{10\ lbs\ VOC \Big/ ton\ coal}{year}\right)(183\ dwelling\ units)\left[0.003874e^{\left(7.6414-\frac{1000}{5494}\right)}\ tons\ coal \Big/ dwelling\ unit\right]$$

$$Annual\ VOC\ Emissions = 12{,}307.7791\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 6.1539\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.000110 [4] [23]
Summer work weekday VOC emissions = 6.1539 × 0.000110 = 0.000675 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{275\ lbs\ CO \big/ tons\ coal}{year} \right) (183\ dwelling\ units) \left[0.003874 e^{\left(7.6414 - \frac{1000}{5494}\right)} tons\ coal \big/ dwelling\ unit \right]$$

$$Annual\ CO\ Emissions = 338{,}463.9245\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 169.2320\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.000110[4 23]
Summer work weekday CO emissions = 169.2320 × 0.000110 = 0.01856 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor=0.00555[4 23]
Winter work weekday CO emissions = 169.2320 × 0.00555 = 0.9389 tons CO per day

Commercial/Institutional Coal Combustion:

$$Annual\ Emissions = (Pollutant\ Emission\ Factor)(Coal\ Consumption)\left(\frac{Number\ of\ County\ Facilities}{Number\ of\ State\ Facilities} \right)$$

where:

VOC Emission Factor = 0.07 lbs/ton anthracite coal/year[28]*; 1.3 lbs/ton bituminous coal/year*[39]

NO_x Emission Factor = 18 lbs/ton anthracite coal/year[39]*; 33 lbs/ton bituminous coal/year*[39]

CO Emission Factor = 0.6 lbs/ton anthracite coal/year[39]*; 11 lbs/ton bituminous coal/year*[39]

Pb Emission Factor = 0.0089 lbs/ton anthracite coal/year[39]*; 0.013182 lbs/ton bituminous coal/year*[39]

SO_2 Emission Factor =39 lbs/ton anthracite coal/year[39]*× 0.89% sulfur content = 34.71 lbs/ton anthracite coal/year; 38 lbs/ton bituminous coal/year*[39] *× 2.42% sulfur content = 91.96 lbs/ton bituminous coal/year*

PM10-FIL Emission Factor = 2.3 lbs/ton anthracite coal/year[39] *× 13.38% ash content = 30.774 lbs/ton anthracite coal/year; 13.2 lbs/ton bituminous coal/year*[39]

PM25-FIL Emission Factor = 0.6 lbs/ton anthracite coal/year[39] *× 13.38% ash content = 8.028 lbs/ton anthracite coal/year; 4.6 lbs/ton bituminous coal/year*[39]

PM-CON Emission Factor = 0.08 lbs/ton anthracite coal/year[39] *× 13.38% ash content = 1.0704 lbs/ton anthracite coal/year; 1.04 lbs/ton bituminous coal/year*[39]

Anthracite Coal Sulfur Content = 0.89%[27]
Bituminous Coal Sulfur Content = 2.42%[27]
Anthracite Coal Ash Content = 13.38% ash[27]
Pennsylvania Coal Consumption = 512,636 tons[25 26]
Number of County Facilities (Allegheny County) = 24,654[2]
Number of Pennsylvania Facilities = 197,795[2]

Commercial/Institutional Coal Consumption: [25 26]

$$State\ Coal\ Consumption = 2000\ Commercial\ Consumption \cdot \frac{2002\ \text{Commercial and Residential Consumption}}{2000\ \text{Commercial and Residential Consumption}}$$

$$= 648{,}000\ tons \cdot \frac{587{,}000\ tons}{742{,}000\ tons} = 512{,}636\ tons$$

VOC Emissions:

$$Annual\ VOC Emissions = \frac{1.3\ lbs\ VOC / ton\ \ bituminous\ coal}{year} \cdot 512{,}636\ tons \cdot \frac{24{,}654\ county\ facilities}{197{,}795\ state\ facilities}$$

$$Annual\ VOC Emissions = 83{,}066.2561\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 41.5331\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00170[4]
Summer work weekday VOC emissions = 41.5331 × 0.00170 = 0.0705 tons VOC per day

CO Emissions:

$$Annual\ \ CO\ Emissions = \frac{11\ lbs\ CO / ton\ \ bituminous\ coal}{year} \cdot 512{,}636\ tons \cdot \frac{24{,}654\ \ county\ \ facilities}{197{,}795\ \ state\ \ facilities}$$

$$Annual\ \ CO\ Emissions = 702{,}868.321\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 351.4342\ \ tons\ CO per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00170[4]
Summer work weekday CO emissions = 351.4342 × 0.00170 = 0.5967 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00397[4]
Winter work weekday CO emissions = 351.4342 × 0.00397 = 1.3962 tons CO per day

Industrial Coal Combustion:

$$Annual\ Emissions = (Pollutant\ Emission\ Factor)(Coal\ Consumption)\left(\frac{Number\ of\ County\ Employees}{Number\ of\ State\ Employees}\right)$$

The Industrial Coal Combustion emissions were calculated using the same emission factors as Commercial/Institutional Coal (see above).

where:

Number of Allegheny County Employees =48,544[2 3]
Number of Pennsylvania Employees = 721,902[2 3]
Pennsylvania Coal Consumption = 42,900,812.75 tons[25 26]

Industrial Coal Consumption:[25 26]

$$State\ Coal\ Consumption =$$

$$2000\ Industrial\ Consumption\ from\ State\ Energy\ Data \cdot \frac{2002\ Other\ Industrial\ Consumption\ (Annual\ Coal\ Report)}{2000\ Other\ Industrial\ Consumption\ (Annual\ Coal\ Report)}$$

$$= 48{,}083{,}000\ tons \cdot \frac{3{,}121{,}000\ tons}{3{,}498{,}000\ tons} = 42{,}900{,}812.75\ tons$$

CO Emissions:

$$Annual\ CO\ Emissions = \frac{11\ lbs\ CO \big/ ton\ \ bituminous\ \ coal}{year} \cdot 42{,}900{,}812.75\ tons \cdot \frac{48{,}544\ employees\ in\ \ county}{721{,}902\ employees\ in\ \ state}$$

$$Annual\ CO\ Emissions = 31{,}733{,}320.58\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 15{,}866.6603\ tons\ \ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00283[4]
Summer work weekday CO emissions = 15,866.6603 × 0.00283 = 44.8538 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00283[4]
Winter work weekday CO emissions = 15,866.6603 × 0.00283 = 44.8538 tons CO per day

COMMERCIAL AND CONSUMER SOLVENT USE (SCC 2465000000)

This source category covers household products such as special naphthas, alcohols, carbonyls, and other organics that contain VOCs. There are no point sources associated with this category. County-level emissions were calculated using a composite per capita emission factor (see table below) and U.S. Bureau of the Census population data. The emission factor represents pre-control emission rates. A CE of 20 percent[29] and an RP of 48.6 percent[9] were applied to reflect the Federal Rule for consumer products. This yields a post-control VOC emission factor of

7.078 lbs per capita which was used in all emission calculations. Each county's emissions are estimated per the sample calculations listed below.

SUBCATEGORY	EMISSION FACTOR
Household Products	0.79 lbs/person/year
Personal Care Products	2.32 lbs/person/year
Automotive Aftermarket Products	1.36 lbs/person/year
Adhesives and Sealants	0.57 lbs/person/year
FIFRA-Regulated Products	1.78 lbs/person/year
Coatings and Related Products	0.95 lbs/person/year
Miscellaneous Products	0.07 lbs/person/year
Total (Pre-Control)	**7.84 lbs/person/year**

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\ VOC\ Emissions = (Emission\ Factor)(Population)\left(1 - \frac{CE}{100} \cdot \frac{RP}{100} \cdot \frac{RE}{100}\right)$$

where:

Emission Factor =7.84 lbs VOC/person/year[30]
Population = 1,269,904 (Allegheny County)[7]
CE (Control Efficiency) = 20%[29]
RP (Rule Penetration) = 48.6% [9]
RE (Rule Effectiveness) = 100%

$$Annual\ VOC\ Emissions = \left(\frac{7.84\ lbs\ VOC / person}{year}\right)(1{,}269{,}904\ people)\left(1 - \frac{20}{100} \cdot \frac{48.6}{100} \cdot \frac{100}{100}\right)$$

$$Annual\ VOC\ Emissions = 8{,}988{,}319.557\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 4494.1598\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00274 [9]
Summer work weekday VOC emissions = 4494.1598× 0.00274 = 12.3128 tons VOC per day

COMMERCIAL COOKING (5 SCCs)

Chain-Driven (Conveyorized) Charbroilers SCC 2302002100; Under-Fired Charbroilers SCC 2302002200; Flat Griddles SCC 2302002300; Clamshell Griddles SCC 2302002400; and Deep-Fat Fryers SCC 2302002500

Criteria pollutant annual emissions associated with commercial cooking were compiled from the 2002 nonpoint source National Emissions Inventory (NEI).[31] The 2002 NEI reports commercial cooking emissions in five SCCs, each of which represents a specific equipment type. Source

categories comprise emissions from all meat types for a particular piece of equipment. The following types of meat are included: hamburger, steak, fish, pork, and chicken. Emissions for deep-fat frying of french fries were also estimated. With the exception of deep-fat frying of french fries, commercial cooking activity was developed from survey data obtained from a Public Research Institute (PRI) report on charbroiling activity estimation in the State of California.[32] Further details on the annual emission estimation methodology are available in the forthcoming 2002 nonpoint source NEI documentation.[31]

The NEI reports emissions for the following criteria pollutants: VOC, CO, PM10-PRI, and PM25-PRI (note, however, that each pollutant is not reported for each equipment type). The sources of the commercial cooking criteria pollutant emission factors are documented in a report prepared for EPA.[33]

Because temporal allocation data were not developed for this category in the 2002 NEI, the default temporal data reported in the EMCH for SCC 2302002000 (Commercial Charbroiling) were applied to each commercial cooking SCC.[4] These data were used to estimate both summer season and winter season work weekday emission estimates.

SAMPLE SEASONAL CALCULATIONS (CHAIN-DRIVEN CHARBROILERS):

Annual VOC emissions (Allegheny County) = 10.7792 tons VOC per year
Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday VOC emissions = 10.7792 × 0.00275 = 0.0296 tons VOC per day

Annual PM10-PRI emissions (Allegheny County) = 43.0837 tons VOC per year
Winter work weekday PM10-PRI emissions = annual PM10-PRI emissions× winter work weekday allocation factor
Winter work weekday allocation factor = 0.00275[4]
Winter work weekday PM10-PRI emissions = 43.0837 × 0.00275 = 0.1185 tons VOC per day

COMPOSTING (3 SCCs)

(Biosolids SCC 2680001000, Mixed Waste 2680002000, Green Waste 2680030000)
Composting refers to the use of both aerobic and anaerobic microbial processes to degrade waste materials for beneficial refuse. Compostable wastes include biosolids (sewage sludge), manure, green waste (e.g., landscape trimmings, grass clippings), and other biodegradable materials such as food waste. Composting produces emissions of NH_3, VOC, and methane. Emissions for each county were estimated using a biosolids-generation-based emission factor[65]. Figures on material composted were obtained from *BioCycle's* nationwide survey[34]

Each county's emissions were estimated per the sample calculations below.

SAMPLE NH_3 EMISSION CALCULATION:

Annual NH_3 Emissions = (Emission Factor)(Tons material composted)

Where:

Emissions Factor = 3.28 lbs NH_3/ton Biosolids
2.81 lbs NH_3/ton Mixed Waste
0.82 lbs NH_3/ton Green Waste

Tons Biosolids = 3,321.65 (Allegheny County)

$$Annual\ NH3\ Emissions = \left[\frac{3.28\ lbs\ NH3/ton\ Biosolids}{year}\right](3{,}321.65\ tons\ Biosolids)$$

$$Annual\ NH_3\ Emissions = 10895.012 * \frac{1\ ton}{2000\ lbs} = 5.45 \text{ tons } NH_3\text{/ year}$$

DEGREASING (4 SCCs)

(Auto Repair (Cold Cleaning) SCC 2415360000, Manufacturing (Cold Cleaning) SCC 2415300000, Electronics (Vapor/In-Line) SCC 2415230000, Other (Vapor/In-Line) SCC 2415200000)

Surface cleaning, also known as "degreasing", includes the solvent cleaning or conditioning of metal surfaces and parts, fabricated plastics, electronic and electrical components and other nonporous substrates. These cleaning processes are designed to remove foreign material, such as oils, grease, waxes and moisture, usually in the preparation for further treatment, such as painting, electroplating, galvanizing, anodizing or applying conversion coatings. Three basic types of surface cleaning operations are currently used: cold cleaning, vapor cleaning, and in-line or conveyorized cleaning, which can be either a cold or vapor cleaning process. VOC emission results from the evaporation of solvents used in these processes.

Cold cleaning is a batch process in which solvents are applied at room temperature or slightly heated. Parts are immersed in a solvent, usually mineral spirits. Parts too large for immersion may be sprayed or wiped with a solvent. The primary cold cleaning application is cleaning of tools or metal parts at service and automotive repair stations and manufacturing facilities. Cold cleaning may incorporate covers or freeboards to limit the evaporative loss of solvents.

In-line cleaners use automated load systems (typically conveyors) to maintain a continuous feed to the cleaning unit. These units use both cold and vapor-cleaning methods as described above, with the majority being halogenated solvent cleaning systems. These units are used for large-scale operations and are usually enclosed except to the conveyor inlet or exit. A common application of in-line cleaners is cleaning printed circuit boards for the electronic and electrical component industries.

The Emission Inventory Improvement Program (EIIP) developed the following population-based methods for estimating degreasing emissions. Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\ VOC\ Emissions = (Emission\ Factor)(Population)\left(1 - \frac{CE}{100} \cdot \frac{RP}{100} \cdot \frac{RE}{100}\right)$$

where:

Auto Repair (Cold Cleaning) VOC Emission Factor = 2.5 lbs VOC/person/year[35]
Manufacturing (Cold Cleaning) VOC Emission Factor = 1.1 lbs VOC/person/year[35]
Electronics (Vapor/In-Line) VOC Emission Factor = 0.21 lbs VOC/person/year[35]
Other (Vapor/In-Line) VOC Emission Factor = 0.49 lbs VOC/person/year[35]
Population = 1,269,904 (Allegheny County)[7]
Auto Repair Cold Cleaning CE (Control Efficiency) = 66%[36]
Manufacturing Cold Cleaning CE (Control Efficiency) = 66%[36]
Electronics Vapor/In-Line CE (Control Efficiency) = 63%[36] [37]
Other Vapor/In-Line CE (Control Efficiency) = 63%[36] [37]
All Categories RP (Rule Penetration) = 100%
All Categories RE (Rule Effectiveness) = 80%

Allegheny County Auto Repair (Cold Cleaning) VOC Emissions Calculation:

$$Annual\ VOC\ Emissions = \left(\frac{2.5\ lbs\ VOC\ /\ person}{year}\right)(1{,}269{,}904\ people)\left(1 - \frac{66}{100} \cdot \frac{100}{100} \cdot \frac{80}{100}\right)$$

$$Annual\ VOC\ Emissions = 1{,}498{,}486.72\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 749.2434\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions calculation for Allegheny County Auto Repair (Cold Cleaning):
Degreasing (all categories) summer work weekday allocation factor = 0.00385 [9]
Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday VOC emissions = 749.2434 × 0.00385 = 2.8817 tons VOC per day

DRY CLEANERS (SCC 2420000370)

Three types of dry cleaning operations are used: coin-operated facilities using perchloroethylene (perc); commercial/industrial facilities using perc; and commercial/industrial facilities using VOC solvents. As perc is no longer considered a VOC, only commercial/industrial facilities using VOC solvents are considered for the area source inventory. The first two categories are not included in the baseline inventory. They are, however, retained for use in the modeling inventory as required by EPA guidance.

Point source emissions, where present, were subtracted from these emission estimates. Each county's emissions were estimated per the sample calculations below using a per capita emission factor and US Census Bureau population data. The emission factor was determined by the Department using 1990 survey data supplied by the industry (contacts with the Pennsylvania and Delaware Cleaners Association indicate that more recent data are not available).[38]

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Population)

where:

Emission Factor = 0.15 lbs VOC/person/year[38]
Population = 1,269,904 (2002 Allegheny County)[7]

$$Annual\ \ VOC\ \ Emissions = \left(\frac{0.15 lbs VOC / person}{year} \right) (1{,}269{,}904\, people)$$

$$Annual\ \ VOC\ \ Emissions = 190{,}485.6\ \ pounds\ \ VOC\ \ \ per\ year \cdot \frac{1\, ton}{2000\, lbs} = 95.2428\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 95.2428× 0.0028=0.2674 tons VOC per day

ELECTRICAL APPLIANCES (SCC 2401060000)

The VOC emissions from this source category result from the evaporation of the solvent used in the coating process in the manufacture of electrical appliances such as refrigerators, freezers, laundry equipment, and electric housewares. Emissions for each county were estimated per the sample calculations below using an employment-based emission factor and the number of employees in the NAICS codes, 333414, 335211, 335212, 335221, and 335228. The number of employees in each county for 2001 was obtained from County Business Patterns[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

Emission Factor = 463 lbs VOC/employee/year[16]
Employees = 150 (Allegheny County) [2, 3]

$$Annual\ VOC\ Emissions = \left(\frac{463\ lbs VOC / employee}{year} \right) (150\ employees)$$

$$Annual\ VOC\ Emissions = 69{,}450\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 34.725\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275 [4]
Summer work weekday VOC emissions = 34.725 x 0.00275=0.0955 tons VOC per day

ELECTRICAL INSULATION (SCC 2401065000)

The VOC emissions from this source category result from the evaporation of the solvent used in the insulation coatings applied to wire and cable. The emissions for each county were calculated using an employment-based emission factor and the number of employees in NAICS codes 331422, 331491, 335311, 335921 and 335929. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Each county's emissions were estimated per the sample calculations below.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:
Emission Factor = 290 lbs VOC/employee/year[16]
Employees = 58 (Allegheny County)[2 3]

$$Annual\ VOC\ Emissions = \left(\frac{290\ lbs VOC / employee}{year} \right) (58\ employees)$$

$$Annual\ VOC\ Emissions = 16820\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 8.41\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00277[4]
Summer work weekday VOC emissions = 8.41 × 0.00277=0.0233 tons VOC per day

FACTORY FINISHED WOOD (SCC 2401015000)

The VOC emissions from this source category result from the evaporation of the solvent used in the gluing and coating process. The emissions for each county were calculated using an employment-based emission factor and the number of employees in NAICS codes 32192, 33711, 321211, 321212, 321213, 321911, 321918, 321992, and 321999. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

Emission Factor = 131 lbs VOC/employee/year[16]
Employees =615 (Allegheny County)[2 3]

$$Annual\ VOC\ Emissions = \left(\frac{131\ lbs VOC / employee}{year} \right) (615\ employees)$$

$$Annual\ VOC\ Emissions = 80565\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 40.2825\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 40.2825 x 0.0028=0.1141 tons VOC per day

FOREST FIRES (SCC 2810001000)

Forest fires in certain rural areas can produce very large, short-term emissions of VOC, NO_x, and CO, SO_2, and particulates. The emissions for each county were calculated using an emission factor from AP-42[39] or the 1999 National Emissions Inventory[40] and a loading factor from AP-42[39]. The number of acres burned was obtained from the Department of Conservation and Natural Resources.[41] Each county's emissions were estimated per the sample calculations below.

SAMPLE CALCULATIONS:

Annual Emissions = (Emission Factor)(Loading Factor)(Acres Burned)

where:

VOC Emission Factor = 24 lbs VOC/ton of flora/year[39]

NO_x Emission Factor = 4 lbs NO_x/ton of flora/year[39]
CO Emission Factor = 140 lbs CO/ton of flora/year[39]
Loading Factor = 11 tons of flora/acre[39]
Acres Burned = 3.85 acres (Westmoreland County)[41]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{24\ lbs\ VOC \Big/ ton\ of\ flora}{year} \right) \left(\frac{11\ tons\ of\ flora}{acre} \right) (3.85\ acres\ burned)$$

$$Annual\ VOC\ Emissions = 1016.4\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 0.5082\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0055[4]
Summer work weekday VOC emissions = 0.5082× 0.0055=0.002795 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{140\ lbs\ CO \Big/ ton\ of\ flora}{year} \right) \left(\frac{11\ tons\ of\ flora}{acre} \right) (3.85\ acres\ burned)$$

$$Annual\ CO\ Emissions = 5929\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 2.9645\ tons\ CO\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0055[4]
Summer work weekday CO emissions = 2.9645× 0.0055=0.0163 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00056[4]
Winter work weekday CO emissions = 2.9645× 0.00056=0.0017 tons CO per day

FUEL OIL COMBUSTION (3 SCCs)

(Residential Distillate Fuel Oil SCC 2104004000, Commercial/Institutional Distillate Fuel Oil SCC 2103004000, Commercial/Institutional Residual Fuel Oil SCC 2103005000)

Distillate and residual oil combustion sources, which emit VOC, NO_x, CO, SO_2, Pb, and PM are grouped into three categories: Commercial/Institutional, Residential, and Industrial. Industrial source emissions are captured in the point source inventory. For Commercial sector categories, point source emissions, where present, were subtracted from the emissions of the corresponding

county. Fuel oil emissions were calculated for each county using fuel use estimates derived by allocating Commonwealth consumption estimates from the Energy Information Administration to individual counties. The county allocations were performed using data obtained from the *County Business Patterns* and the U.S. Census Bureau.

SAMPLE CALCULATIONS:

Residential Distillate Fuel Oil:

Residential fuel oil usage was determined by allocating the total residential fuel oil use to each county. The residential fuel oil consumption was allocated by the ratio of dwelling units (DU) using distillate fuel oil in a county to the number of dwelling units burning distillate fuel oil in the Commonwealth. The following is the general equation for the calculation of usage for residential sources of fuel oil combustion.

$$Annual\ Fuel\ Oil\ Usage = (PA\ Residential\ Distillate\ Fuel\ Oil\ Usage)\left(\frac{County\ Fuel\text{-}Oil\text{-}Burning\ DU}{State\ Fuel\text{-}Oil\text{-}Burning\ DU}\right)$$

where:

PA Residential Distillate Fuel Use = 829,470 thousands of gallons[42]
2000 County Fuel-Oil-Burning DUs = 8123 Dwelling Units (Allegheny County)[7]
2000 State Fuel-Oil-Burning DUs = 1,217,155 Dwelling Units[7]

VOC Emissions:

$$Annual\ VOC\ Emissions = \frac{0.7\ lbs\ VOC}{1000\ gallons} \cdot 829{,}470\ thousands\ of\ gallons \cdot \frac{8123\ Dwelling\ Units}{1{,}217{,}155\ Dwelling\ Units}$$

$$Annual\ VOC\ Emissions = 3874.9784\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 1.9375\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.000165[4]
Summer work weekday VOC emissions = 1.9375 × 0.000165 = 0.000319 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \frac{5\ lbs\ VOC}{1000\ gallons} \cdot 829{,}470\ thousands\ of\ gallons \cdot \frac{8123\ Dwelling\ Units}{1{,}217{,}155\ Dwelling\ Units}$$

$$Annual\ CO\ Emissions = 27{,}678.4173\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 13.8392\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.000165[4]
Summer work weekday CO emissions = 13.8392 × 0.000165 = 0.00228 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.000626[4]
Winter work weekday CO emissions = 13.8392× 0.00626=0.0866 tons CO per day

Commercial/Institutional Distillate Fuel Oil:

The total amount of distillate fuel oil was apportioned to each county according to the number of commercial sector (i.e., SIC code 50-89) facilities. The number of commercial facilities in 2001 was used for this allocation because 2001 data were the last year available.[2] Total Commonwealth use was obtained from the Energy Information Administration.[42] Each county's emissions for commercial/institutional fuel oil combustion were estimated per the following sample calculations.

$$Annual\,Emissions = (Emission\,Factor)(PA\,Commercial/Institutional\,Distillate\,Fuel\,Oil\,Use)\left(\frac{Number\,of\,County\,Facilities}{Number\,of\,State\,Facilities}\right)$$

where:

VOC Emission Factor = 0.34 lbs/1000 gallons/year[39]
NO_x Emission Factor = 20 lbs/1000 gallons/year[39]
CO Emission Factor = 5 lbs/1000 gallons/year[39]
SO_2 Emission Factor = 142 lbs/1000 gallons/year[39] *× 0.3% sulfur content = 42.6 lbs/1000 gallons/year*
PM10-FIL Emission Factor = 1.08 lbs/1000 gallons/year[39]
PM25-FIL Emission Factor = 0.83 lbs/1000 gallons/year[39]
PM-CON Emission Factor = 1.3 lbs/1000 gallons/year[39]
Lead Emission Factor = 0.001268 lbs/1000 gallons/year ***Error! Bookmark not defined.***
Distillate Fuel Sulfur Content = 0.3%[27]
County Facilities = 24,654 (Allegheny County)[2]
Commonwealth Facilities = 197,795[2]
PA Commercial/Institutional Distillate Fuel Oil Use = 301,554,000 gallons[42]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{0.34 lbs VOC / 1000 gallons}{year}\right)(301{,}554\ thousands\ of\ gallons)\left(\frac{24{,}654 Facilities}{197{,}795 Facilities}\right)$$

$$Annual\ VOC\ Emissions = 12{,}779.5656\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 6.3898\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00170[4]
Summer work weekday VOC emissions = 6.3898 × 0.00170=0.0108 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{5\ lbsCO \Big/ 1000 gallons}{year} \right) (301{,}554\ thousands\ of\ gallons) \left(\frac{24{,}654 Facilities}{197{,}795 Facilities} \right)$$

$$Annual\ CO\ Emissions = 187{,}934.7889\ pounds\ CO\ \ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 93.9674\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00170[4]
Summer work weekday CO emissions = 93.9674 × 0.00170=0.1595 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.0040[4]
Winter work weekday CO emissions = 93.9674 × 0.0040=0.3733 tons CO per day

<u>*Commercial/Institutional Residual Fuel Oil*</u>:

The total amount of residual fuel oil was apportioned to each county according to the number of commercial facilities, which was obtained from *County Business Patterns*.[2] The total Commonwealth use was obtained from the Energy Information Administration.[42] Each county's emissions for commercial/institutional fuel oil combustion were estimated per the following sample calculations.

$$Annual\ \ Emissions\ \ = (Emission\ \ \ Factor)(\text{PA Commercial Residual Fuel Oil Use}) \left(\frac{Number\ \ of\ \ County\ \ \ Facilities}{Number\ \ of\ \ State\ \ Facilities} \right)$$

where:

VOC Emission Factor = 1.13 lbs/1000 gallons/year[39]
NO_x Emission Factor = 55 lbs/1000 gallons/year[39]
CO Emission Factor = 5 lbs/1000 gallons/year[39]
SO_2 Emission Factor = 157 lbs/1000 gallons/year[39] *× 1.05% sulfur content = 164.85 lbs/1000 gallons/year*
PM10-FIL Emission Factor = 5.17 lbs/1000 gallons/year × 0.19% ash content = 0.9823 lbs/1000 gallons/year[39]
PM25-FIL Emission Factor = 1.92 lbs/1000 gallons/year × 0.19% ash content = 0.3648 lbs/1000 gallons/year[39]
PM-CON Emission Factor = 1.5 lbs/1000 gallons/year[39]
Lead Emission Factor = 0.00155 lbs/1000 gallons/year ***Error! Bookmark not defined.***
Residual Fuel Sulfur Content = 1.05% [43]
County Facilities = 24,654 (Allegheny County)[2]
Commonwealth Facilities = 197,795[2]
PA Commercial/Institutional Residual Fuel Oil Use = 16,597,000 *gallons*[42]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{1.13\ lbs\ VOC \Big/ 1000\ gallons}{year} \right) (16{,}597\ thousands\ of\ gallons) \left(\frac{24{,}654\ Facilities}{197{,}795\ Facilities} \right)$$

$$Annual\ VOC\ Emissions = 2337.6534\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 1.1688\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00170[4]
Summer work weekday VOC emissions = 1.1688 × 0.00170= 0.00198 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{5\ lbs\ CO \Big/ 1000 gallons}{year} \right) (16{,}597\ thousands\ of\ gallons) \left(\frac{24{,}654 Facilities}{197{,}795 Facilities} \right)$$

$$Annual\ CO\ Emissions = 10{,}343.5991\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 5.1718\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00170 [4]
Summer work weekday CO emissions = 5.1718 × 0.00170=0.00878 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.0040 [4]
Winter work weekday CO emissions = 5.1718 × 0.0040 = 0.0205 tons CO per day

GASOLINE MARKETING (5 SCCs)

(Stage I SCC 2501060053, Stage II Uncontrolled SCC 2501060101, Stage II Controlled SCC 2501060102, Underground Storage Tank Breathing and Emptying SCC 2501060201, Truck Transit SCC 2505030120)

Gasoline marketing involves the operations typically associated with transporting gasoline from refineries to final consumption in gasoline-powered vehicles. Evaporative emissions of VOCs occur at all points in the distribution process. The operations that were inventoried as area sources are gasoline dispensing outlets and gasoline tank trucks in transit. Bulk terminals and outlets are inventoried as point sources. VOC emissions result from the following sources: 1)

Stage I (tank truck unloading into underground storage tanks), 2) Stage II (vehicle fueling), 3) Underground Storage Tank Breathing and Emptying, and 4) Truck Transit.

Each category's AP-42 emission factor is based on the average daily throughput that was calculated from monthly data obtained from the Pennsylvania Department of Revenue Bureau of Motor Fuel Taxes. The vehicle miles traveled (VMT), which were obtained from Dan Szekeres of the Baker Corporation[44], was used to apportion the gasoline throughput to each county. Control efficiency (CE), rule penetration (RP), and rule effectiveness (RE) factors were applied to Stage I for each county to reflect the application of vapor balance systems. A RE factor was applied to Stage II to each regulated county. CE, RP, and RE factors were applied to Underground Storage Tank Breathing to reflect the application of pressure relief valves. There were no point sources for this source category. Each county's emissions were estimated per the following sample calculations.

SAMPLE VOC EMISSION CALCULATIONS:

Stage I:

$$Annual\ VOC\ Emissions = (Emission\ Factor)(State\ Annual\ Gasoline\ Sales)\left(\frac{County\ Annual\ VMT}{State\ Annual\ VMT}\right)$$

where:

Emission Factor = 1.92 lbs VOC/1000 gallons[39]
State Annual Gasoline Sales = 5,238,145,337 gallons/year[45]
County Annual VMT = 8,836,074,725 miles (Allegheny County) [44]
State Annual VMT = 97,021,666,321 miles[44]
Control Efficiency (CE) = 96%[46] [47]
Rule Penetration (RP) = 96%[46] [47]
Rule Effectiveness (RE) = 80%

$$Annual\ VOC\ Emissions = \left(\frac{1.92\ lbs\ VOC}{1000\ gallons}\right)\left(\frac{5{,}238{,}145{,}337\ gallons}{day}\right)\left(\frac{8{,}836{,}074{,}725\ miles}{97{,}021{,}666{,}321\ miles}\right)\left(1-\frac{96}{100}\cdot\frac{96}{100}\cdot\frac{80}{100}\right)$$

$$Annual\ VOC\ Emissions = 240{,}637.0855\ pounds\ VOC\ per\ year\cdot\frac{1\ ton}{2000\ pounds} = 120.3185\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month gasoline sales/annual gasoline sales × weekday ratio/number of weekdays in summer
Summer work weekday allocation factor = 1,370,092,015/5,238,145,337× 0.8333/65 = 0.00335 [4] [45]
Summer work weekday VOC emissions = 120.3185 × 0.00335 = 0.4035 tons VOC per day

Stage II:

Vehicle refueling VOC emissions are estimated using MOBILE6.2-based emission factors;[48] monthly gasoline sales estimates;[45] and county-level, annual vehicle miles traveled (VMT) data.[44] MOBILE6.2 provided monthly, emission factors for each county in Pennsylvania.

MOBILE6.2 input files were set up to model refueling emission factors in a manner similar to that used for calculating onroad mobile source emissions for 2002. For each county, twelve monthly scenarios were modeled, along with an ozone season scenario and a winter scenario. These scenarios used the same 2002 monthly temperature and fuel inputs that were used in preparing onroad mobile source emissions. Each input file also called upon the external county-specific age distribution file developed for 2002. No speed information or I/M program information was modeled, as these are not needed in the refueling calculations.

Stage II control program information was included for the counties with controls based on program information regarding control efficiency from Pennsylvania. The Pennsylvania counties with Stage II controls are Allegheny, Armstrong, Beaver, Bucks, Butler, Chester, Delaware, Fayette, Montgomery, Philadelphia, Washington, and Westmoreland.[49] Vehicle-specific emission factors were then obtained in the database output format of MOBILE6.2. Using the fuel economy data and VMT fraction data contained in the MOBILE6.2 output files, the gram per mile emission factors were first converted to gram per gallon emission factors. These gram per gallon emission factors were then weighted according to the VMT fraction of each gasoline vehicle type to obtain monthly, county-specific gram per gallon emission factors weighted for all gasoline vehicle types.

VMT data were used to allocate monthly Pennsylvania gasoline sales to each county. These are the same gasoline sales figures that are used to estimate Stage I emissions. The MOBILE6.2 emission factors were then multiplied by the corresponding gasoline sales data to estimate refueling emissions. The VOC emissions calculations provide emissions at the county level for each month of 2002.

$$Allegheny\ June\ VOC\ Emissions = (VOC\ Emission\ Factor)(Monthly\ State\ Gasoline\ Sales)\left(\frac{County\ VMT}{State\ VMT}\right)$$

where:

Allegheny County June Emission Factor = 1.027 grams/gallon[48]
PA June Gasoline Consumption =443,778,938 gallons[45]
Allegheny County 2002 VMT = 8,836,074,725 miles[44]
PA 2002 VMT = 97,021,666,321 miles[44]

$$Allegheny\ June\ VOC\ Emissions = \left(\frac{1.027\ g\ VOC}{gallon}\right)(443{,}778{,}938\ gallons)\left(\frac{8{,}836{,}074{,}725\ miles}{97{,}021{,}666{,}321\ miles}\right)$$

$$Allegheny\ June\ VOC\ Emissions = 41{,}507{,}615.1\ g\ VOC \cdot \frac{1\ lb}{453.59\ g} \cdot \frac{1\ ton}{2000\ lb} = 45.7546\ tons\ VOC$$

$$Annual\ Allegheny\ County\ VOC\ Emissions = \sum Monthly\ Allegheny\ County\ Emissions = 573.8276\ tons\ VOC$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month gasoline sales/annual gasoline sales ×
weekday ratio/number of weekdays in summer

Summer work weekday allocation factor = 1,370,092,015/5,238,145,337× 0.715/65 = 0.00288 [4] [45]
Summer work weekday VOC emissions = 573.8276 × 0.00288 = 1.6510 tons VOC per day

Underground Storage Tank Breathing and Emptying:

$$Annual\ VOC\ Emissions = (Emission\ Factor)(State\ Annual\ Gasoline\ Sales)\left(\frac{County\ Annual\ VMT}{State\ Annual\ VMT}\right)$$

where:

Emission Factor = 1.0 lbs VOC/1000 gallons[39]
State Annual Gasoline Sales = 5,238,145,337 gallons/year[45]
County Annual VMT = 8,836,074,725 miles (Allegheny County) [44]
State Annual VMT = 97,021,666,321 miles[44]
Control Efficiency (CE) = 90% [46] [50]
Rule Penetration (RP) = 96%[46] [50]
Rule Effectiveness (RE) = 80%

$$Annual\ VOC\ Emissions = \left(\frac{1.0\ lbs\ VOC}{1000\ gallons}\right)\left(\frac{5{,}238{,}145{,}337\ gallons}{day}\right)\left(\frac{8{,}836{,}074{,}725\ miles}{97{,}021{,}666{,}321\ miles}\right)\left(1-\frac{90}{100}\cdot\frac{96}{100}\cdot\frac{80}{100}\right)$$

$$Annual\ VOC\ Emissions = 147{,}314.4698\ pounds\ VOC\ per\ year\cdot\frac{1\ ton}{2000\ pounds} = 73.6572\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month gasoline sales/annual gasoline sales ×
weekday ratio/number of weekdays in summer
Summer work weekday allocation factor = 1,370,092,015/5,238,145,337× 0.715/65 = 0.00288 [4] [45]
Summer work weekday VOC emissions = 73.6572 × 0.00288 = 0.2119 tons VOC per day

Truck Transit:

$$Annual\ VOC\ Emissions = (Emission\ Factor)(State\ Annual\ Gasoline\ Sales)\left(\frac{County\ Annual\ VMT}{State\ Annual\ VMT}\right)$$

where:

Emission Factor = 0.06 lbs VOC/1000 gallons[39]
State Annual Gasoline Sales = 5,238,145,337 gallons/year[45]
County Annual VMT = 8,836,074,725 miles (Allegheny County) [44]
State Annual VMT = 97,021,666,321 miles[44]

(The emission factor is based on the assumption that gasoline delivery is via single trips and accounts for both full and empty truck travel.)

$$Annual\ VOC\ \ Emissions = \left(\frac{0.06\ \ lbs\ \ VOC}{1000\ \ gallons}\right)\left(\frac{5{,}238{,}145{,}337\ \ gallons}{day}\right)\left(\frac{8{,}836{,}074{,}725\ \ miles}{97{,}021{,}666{,}321\ \ miles}\right)$$

$$Annual\ VOC\ \ Emissions = 28{,}623.2831\ \ pounds\ VOC\ \ per\ \ year \cdot \frac{1\ \ ton}{2000\ \ pounds} = 14.3116\ \ tons\ VOC\ \ per\ \ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month gasoline sales/annual gasoline sales × weekday ratio/number of weekdays in summer
Summer work weekday allocation factor = 1,370,092,015/5,238,145,337× 0.8333/65 = 0.00335 [4 45]
Summer work weekday VOC emissions = 14.3116 × 0.00335 = 0.04799 tons VOC per day

GRAPHIC ARTS (SCC 2425000000)

Graphic arts include operations that are involved in the printing of newspapers, magazines, books, and other printed material. Emissions of VOCs result from evaporation of solvents used in inks and cleaning. The emissions for each county were calculated using a per capita emission factor and U.S. Census Bureau population data. Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Population)

where:
Emission Factor = 1.3 lbs VOC/person/year[16]
Population = 1,269,904 (Allegheny County)[7]

$$Annual\ VOC\ Emissions = \frac{1.3\ lbs\ VOC \big/ person}{year} \cdot 1{,}269{,}904\ people$$

$$Annual\ VOC\ Emissions = 1{,}650{,}875.2\ \ pounds\ \ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 825.4376\ \ tons\ \ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 825.4376 × 0.0028=2.2904 tons VOC per day

HIGH PERFORMANCE INDUSTRIAL MAINTENANCE SOLVENT (SCC 2401100000)

The VOC emissions from this source category result from the evaporation of solvents from surface coating of objects and materials that may exist in extreme conditions. There were no point sources. The emissions for each county were calculated using a per capita emission factor

and U.S. Census Bureau population data. Each county's emissions were estimated per the following sample calculations.

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\ VOC\ Emissions = (Emission\ \ Factor)(Population)\left(1 - \frac{CE}{100} \cdot \frac{RP}{100} \cdot \frac{RE}{100}\right)$$

where:

Emission Factor = 0.8 lbs VOC/person/year[16]
Population = 1,269,904 people (Allegheny County)[7]
CE (Control Efficiency) = 20% [5]
RP (Rule Penetration) = 100%
RE (Rule Effectiveness) = 100%

$$Annual\,VOC\ Emissions = \frac{0.8\,lbs\,VOC \,/\, person}{year} \cdot 1{,}269{,}904\ people \cdot \left(1 - \tfrac{20}{100} \cdot \tfrac{100}{100} \cdot \tfrac{100}{100}\right)$$

$$Annual\,VOC\ Emissions = 812{,}738.56\ pounds\ VOC\ per\ year \cdot \frac{1\,ton}{2000\,lbs} = 406.3693\,tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00356 [9]
Summer work weekday VOC emissions = 406.3693 × 0.00356=1.4473 tons VOC per day

KEROSENE (2 SCCs)

(Residential Kerosene SCC 2104011000, Commercial/Institutional Kerosene SCC 2103011000)

Kerosene combustion sources, which emit VOC, NO_x, CO, SO_2, and PM are grouped into two area source categories: Commercial/Institutional and Residential (all Industrial sector kerosene emissions are assumed to be included in the point source inventory). Emissions were calculated for each county using emission factors and Energy Information Administration fuel use information. The EIA kerosene consumption data are reported for each State. Commonwealth consumption was allocated to counties using data obtained from the *County Business Patterns* and the U.S. Census Bureau.

SAMPLE CALCULATIONS:

Residential Kerosene:

The emissions for residential kerosene combustion were determined by allocating total residential kerosene consumption in the Commonwealth to each county. This allocation was performed using the ratio of dwelling units (DU) heating with kerosene in a county to the number of dwelling units heating with kerosene in the Commonwealth. The following is the general equation used to calculate emissions from residential kerosene combustion.

$$Annual\ Emissions = (Emission\ Factor)(PA\ Residential\ Kerosene\ Fuel\ Oil\ Usage)\left(\frac{County\ Kerosene-Burning\ DU}{State\ Kerosene-Burning\ DU}\right)$$

where:

VOC Emission Factor = 0.7 lbs/1000 gallons/year[27]
NO_x Emission Factor = 17.4 lbs/1000 gallons/year[27]
CO Emission Factor = 4.8 lbs/1000 gallons/year[27]
SO_2 Emission Factor = 41.1 lbs/1000 gallons/year[27]
PM10-FIL Emission Factor = 1.08 lbs/1000 gallons/year[39]
PM25-FIL Emission Factor = 0.83 lbs/1000 gallons/year[39]
PM-CON Emission Factor = 1.3 lbs/1000 gallons/year[39]
PA Residential Kerosene Fuel Use = 83,366 thousands of gallons[42]
2000 County Kerosene-Burning DUs = 8123 Dwelling Units (Allegheny County)[7]
2000 State Kerosene-Burning DUs = 1,217,155 Dwelling Units[7]

<u>*VOC Emissions*</u>:

$$Annual VOC\ Emissions = \frac{0.7\ lbs\ VOC}{1000\ gallons} \cdot 83{,}366\ thousands\ of\ gallons \cdot \frac{8123\ Dwelling\ Units}{1{,}217{,}155\ Dwelling\ Units}$$

$$Annual VOC\ Emissions = 389.4553\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 0.1947\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday VOC emissions =0.1947 × 0.00275=0.000536 tons VOC per day

<u>*CO Emissions*</u>:

$$Annual\ CO\ Emissions = \frac{4.8\ lbs\ VOC}{1000\ gallons} \cdot 83{,}366\ thousands\ of\ gallons \cdot \frac{8123\ Dwelling\ Units}{1{,}217{,}155\ Dwelling\ Units}$$

$$Annual\ CO\ Emissions = 2670.5503\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 1.3353\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday CO emissions = 1.3353 × 0.00275=0.00367 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00275[4]
Winter work weekday CO emissions = 1.3353 × 0.00275=0.00367 tons CO per day

<u>*Commercial/Institutional Kerosene*</u>:

The total amount of fuel oil was apportioned to each county according to the number of commercial facilities, which was obtained from *County Business Patterns*.[2] The total Commercial/Institutional kerosene consumption in the Commonwealth was obtained from the Energy Information Administration.[42] The emission factors used for Commercial/Institutional Kerosene were the same as those used for Commercial/ Institutional Distillate Fuel Oil as per EIIP guidance. Each county's emissions for commercial/institutional fuel oil combustion were estimated per the following sample calculations.

$$Annual\,Emissions = (Emission\,Factor)(PA\,Commercial\,Kerosene\,Use)\left(\frac{Number\,of\,County\,Facilities}{Number\,of\,State\,Facilities}\right)$$

where:

VOC Emission Factor = 0.34 lbs/1000 gallons/year[39]
NO_x Emission Factor = 20 lbs/1000 gallons/year[39]
CO Emission Factor = 5 lbs/1000 gallons/year[39]
SO_2 Emission Factor = 142 lbs/1000 gallons/year[39] *× 0.3% sulfur content = 42.6 lbs/1000 gallons/year*
PM10-FIL Emission Factor = 1.08 lbs/1000 gallons/year[39]
PM25-FIL Emission Factor = 0.83 lbs/1000 gallons/year[39]
PM-CON Emission Factor = 1.3 lbs/1000 gallons/year[39]
Kerosene Sulfur Content = 0.3%[27]
County Commercial Sector Facilities = 24,654 (Allegheny County)[2]
Commercial/Institutional Kerosene Oil Use = 16,290 thousands of gallons[42]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{0.34 lbs\,VOC \big/ 1000 gallons}{year}\right)(16{,}290\ thousands\ of\ gallons)\left(\frac{24{,}654 Facilities}{197{,}795 Facilities}\right)$$

$$Annual\ VOC\ Emissions = 690.3544\ pounds\ VOC\ per\ year \cdot \frac{1\,ton}{2000\ pounds} = 0.3452\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00283[4]
Summer work weekday VOC emissions = 0.3452 × 0.00283 = 0.000976 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{5\ lbsCO \Big/ 1000 gallons}{year} \right) (16{,}290\ thousands\ of\ gallons) \left(\frac{24{,}654 Facilities}{197{,}795 Facilities} \right)$$

$$Annual\ CO\ Emissions = 10152.2703\ pounds\ CO\ \ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 5.0761 tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00283[4]
Summer work weekday CO emissions = 5.0761 × 0.00283 = 0.0143 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00283[4]
Winter work weekday CO emissions = 5.0761 × 0.00283 = 0.0143 tons CO per day

LANDFILLS (SCC 2620030000)

Municipal solid waste landfills receive primarily household and/or commercial waste. The VOC emissions from landfills are produced by volatilization, chemical reaction, and biological decomposition of refuse material.

The emissions were calculated using the total amount of refuse in Pennsylvania's municipal solid waste landfills, not the landfills' capacity. Since landfills continue to emit VOCs long after they are closed (at least 20 years), data from active and inactive landfills were collected.

For active landfills, data from page two of the 2002 "Annual Facility Capacity Report" for each landfill were collected. In particular, Total Waste Accepted was needed for the final emissions calculation.

Several landfills that were included in the 1996 Pennsylvania area source inventory were not included in the compilation of 2002 facility reports provided by PA DEP. After confirming with PA DEP that these landfills are inactive (in a few cases the landfills had merely been renamed), the 1996 Total Waste Accepted data for these now-closed landfills were incorporated into the 2002 inventory.

Total Waste Accepted was summed at the county level to calculate the total landfill emissions in each county. The emissions estimate was adjusted for precipitation. Each county's emissions were estimated per the following sample calculation.

SAMPLE VOC EMISSION CALCULATION:

Annual VOC Emissions = (Emission Factor)(Precipitation Adjustment Factor)(Tons of Waste)

where:

Emission Factor = 13.6 tons VOC/1,000,000 tons of waste
Precipitation Adjustment Factor = 2.6
Amount of Waste = 19,422,841.6 tons of waste (Allegheny County)

$$Annual\ VOC\ Emissions = \left(\frac{13.6\ tons\ VOC \Big/ 1{,}000{,}000\ tons\ waste}{year} \right)(2.6)(19{,}422{,}841.6\ tons\ of\ waste)$$

$$Annual\ VOC\ Emissions = 686.7917\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275 [4]
Summer work weekday VOC emissions = 686.7917 × 0.00275 = 1.8887 tons VOC per day

MACHINERY AND EQUIPMENT (SCC 2401055000)

The VOC emissions from this source category result from the evaporation of the solvent used in the coating process in manufacturing facilities, such as engines, turbines, farm and garden equipment, computers, and office machinery. The emissions for each county were calculated using an employment-based emission factor and employee data from NAICS Codes 333 (except 333314 and 333315), 33271, 332991, 332997, 3341, and 336391. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Point source emissions, where present, were subtracted from the Machinery and Equipment category emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

VOC Emission Factor = 77 lbs VOC /employee/year[16]
Employees = 4944 employees (Allegheny County)[2 3]

$$Annual\ VOC\ Emissions = \left(\frac{77\ lbs\ VOC \Big/ employee}{year} \right)(4944\ employees)$$

$$Annual\ VOC\ Emissions = 380{,}688\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 190.344\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00277[4]

Summer work weekday VOC emissions = 190.344 × 0.00277 = 0.5282 tons VOC per day

MARINE COATING (SCC 2401080000)

This source category includes ship and boat building and repairing. The emissions were calculated using an employment-based emission factor and employee data from NAICS code 33661. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Each county's emissions were estimated per the following sample calculations below. Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

Emission Factor = 308 lbs VOC /employee/year[16]
Employees = 52 employees (Allegheny County)[2 3]

$$Annual\ VOC\ Emissions = \left(\frac{308\ lbs VOC \,/\, Employee}{year} \right) (52\ Employees)$$

$$Annual\ VOC\ Emissions = 16{,}016\ \ pounds\ VOC\ \ per\ \ year \cdot \frac{1\ ton}{2000\ lbs} = 8.008\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 8.008 × 0.0028 = 0.0222 tons VOC per day

METAL CANS (SCC 2401040000)

This source category includes the manufacturing of metal cans, barrels, drums, kegs, and pails. The emissions from point sources, where present, were subtracted from the emissions of the corresponding county. The emissions for each county were calculated per the calculation below using an employment-based emission factor and employee data from NAICS Codes 332431 and 332439. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATION:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

Emission Factor = 6,029 lbs VOC/employee/year[16]
Employees =48 employees (Allegheny County)[2 3]

$$Annual\ VOC\ Emissions = \left(\frac{6{,}029\ lbs VOC \big/ Employee}{year} \right) (48\ Employees)$$

$$Annual\ VOC\ Emissions = 289{,}392\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 144.696\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 144.696 × 0.0028 = 0.4015 tons VOC per day

METAL FURNITURE AND FIXTURES (SCC 2401025000)

This source category includes manufacturing metal household and office furniture, such as beds, cabinets, desks, bookcases, and chairs. The emissions for each county were calculated per the sample calculations below using an employment-based emission factor and employee data for NAICS codes 337121, 337124, 337214, and 337215. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

Emission Factor = 1,597 lbs VOC /employee/year[16]
Employees = 487 employees (Allegheny County)[2 3]

$$Annual\ VOC\ Emissions = \left(\frac{1{,}597\ lbs VOC \big/ employee}{year} \right) (487\ employees)$$

$$Annual\ VOC\ Emissions = 777{,}739\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 388.8695\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 388.8695 × 0.0028 = 1.0790 tons VOC per day

MISCELLANEOUS FINISHED METAL (SCC 2401050000)

This source category includes facilities which enamel, lacquer, and/or varnish metals. The emissions for each county were calculated per the sample calculations below using an employment-based emission factor and employee data from NAICS Codes 332812, 339911, 339912, and 339914. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS).[3] Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

Emission Factor = 2,877 lbs VOC/employee/year[16]
Employees = 683 employees (Allegheny County)[2 3]

$$Annual\ VOC\ Emissions = \left(\frac{2877\ lbs\ VOC \big/ employee}{year} \right) (683\ employees)$$

$$Annual\ VOC\ Emissions = 1{,}964{,}991\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ pounds} = 982.4955\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 982.4955 × 0.0028 = 2.7262 tons VOC per day

MISCELLANEOUS MANUFACTURING (SCC 2401090000)

This source category includes establishments primarily engaged in manufacturing products not classified in any other group such as jewelry, silverware, musical instruments, dolls, toys, games, pens, pencils, buttons, brooms, and caskets. The emissions for each county were calculated per the sample calculations below using a per capita emission factor and U.S. Census Bureau population data. Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Population)

where:

Emission Factor = 0.6 lbs VOC/person/year[16]
Population =1,269,904 (Allegheny County)[7]

$$Annual\ VOC\ Emissions = \left(\frac{0.6\ lbs\ VOC\ /\ person}{year} \right) (1{,}269{,}904\ people)$$

$$Annual\ VOC\ Emissions = 761{,}942.4\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 380.9712\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC Emissions = 380.9712 × 0.0028 = 1.0633 tons VOC per day

NATURAL GAS AND LIQUIFIED PETROLEUM GAS (LPG) (4 SCCs)

(Residential Natural Gas SCC 2104006000, Commercial/Institutional Natural Gas SCC 2103006000, Residential LPG SCC 2104007000, Commercial/Institutional LPG SCC 2103007000)

Natural gas and LPG are used in residential, commercial/institutional, and industrial facilities. Industrial natural gas and LPG consumption is considered to be covered in the point source inventory. Area source natural gas and LPG emissions were estimated using fuel consumption data and AP-42 emission factors. Because monthly natural gas consumption data were available, these data were used in developing the summer and winter season work weekday allocation factors. Consumption data were apportioned according to the number of dwelling units heating with natural gas/LPG, which was available from U.S. Census Bureau data (for residential sources), and according to the number of commercial sector facilities, obtained from County Business Patterns (for commercial/institutional sources). Commercial and Residential LPG consumption was not available for 2002; therefore, the 2001 consumption was grown to 2002 by

applying the ratio of 2002 Commercial/Residential propane sales in Pennsylvania to 2001 Commercial/Residential propane sales in the Commonwealth. Commercial LPG consumption in 2001 was obtained from the Energy Information Administration's *State Energy Data 2001*. Propane sales for 2001 and 2002 were obtained from *Petroleum Marketing Annual.*[51] [52] Each county's emissions were estimated using the sample calculations below. For Commercial sector categories, point sources, where present, were subtracted from the emissions of the corresponding county.

SAMPLE CALCULATIONS:

Natural Gas:

Residential Natural Gas:

$$Annual\ Emissions = (Emission\ Factor)(Statewide\ Residential\ Natural\ Gas\ Consumption) \cdot \left(\frac{Natural\text{ - }Gas\text{ - }Burning\ County\ Dwelling\ Units}{Natural\text{ - }Gas\text{ - }Burning\ State\ Dwelling\ Units} \right)$$

where:

VOC Emission Factor = 5.5 lbs/MMcf (million cubic feet)/year[39]
NO_x Emission Factor = 94 lbs/MMcf/year[39]
CO Emission Factor = 40 lbs/MMcf/year[39]
SO_2 Emission Factor = 0.6 lbs/MMcf/year[39]
PM10-FIL Emission Factor = 1.9 lbs/MMcf/year[39]
PM25-FIL Emission Factor =1.9 lbs/MMcf/year[39]
PM-CON Emission Factor =5.7 lbs/MMcf/year[39]
Pb Emission Factor = 0.0005 lbs/MMcf/year[39]
Residential Natural Gas Consumption = 237,640 MMcf[53]
County Dwelling Units Heating with Natural Gas = 474,292 (Allegheny County)[7]
State Dwelling Units Heating with Natural Gas = 2,452,941 units[7]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{5.5 lbs VOC \,/\, MMcf}{year} \right) (237{,}640 MMcf) \left(\frac{474{,}292\ county\ dwelling\ units}{2{,}452{,}941\ state\ dwelling\ units} \right)$$

$$Annual\ VOC\ Emissions = 252{,}720.7666\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 126.3604\ tons\ \ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.000783[54]
Summer work weekday VOC emissions = 126.3604 × 0.000783 = 0.0989 tons VOC per day

CO Emissions:

$$Annual\ \ CO\ Emissions = \left(\frac{40\ lbs\ \ VOC \Big/ MMcf}{year} \right) (237{,}640 MMcf) \left(\frac{474{,}292\ \ county\ \ dwelling\ \ units}{2{,}452{,}941\ \ state\ \ dwelling\ \ units} \right)$$

$$Annual\ \ CO\ Emissions = 1{,}837{,}969.211\ pounds\ \ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 918.9846\ \ tons\ \ CO\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.000783[54]
Summer work weekday CO emissions = 918.9846 × 0.000783 = 0.7196 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor =0.00526[54]
Winter work weekday CO emissions = 918.9846 × 0.00526 = 4.8370 tons CO per day

<u>*Commercial/Institutional Natural Gas*</u>:

$$Annual\ Emissions = (EmissionFactor)(PA\ \ CommercialNaturalGasConsumption) \left(\frac{CountyCommercialUnits}{StateCommercialUnits} \right)$$

where:

VOC Emission Factor = 5.5 lbs/MMcf (million cubic feet)/year[39]
NO_x Emission Factor = 100 lbs/MMcf/year[39]
CO Emission Factor = 84 lbs/MMcf/year[39]
SO_2 Emission Factor = 0.6 lbs/MMcf/year[39]
PM10-FIL Emission Factor = 1.9 lbs/MMcf/year[39]
PM25-FIL Emission Factor = 1.9 lbs/MMcf/year[39]
PM-CON Emission Factor = 5.7 lbs/MMcf/year[39]
Pb Emission Factor = 0.0005 lbs/MMcf/year[39]
Commercial Natural Gas Consumption = 148,346 MMcf[53]
County Commercial Sector Facilities = 24,654 (Allegheny County)[2]
Commonwealth Commercial Sector Facilities = 197,795[2]

<u>*VOC Emissions*</u>:

$$Annual\ VOC\ Emissions = \left(\frac{5.5 lbs VOC \Big/ MMcf}{year} \right) (148{,}346 MMcf) \left(\frac{24{,}654\ \ county\ \ commercial\ \ units}{197{,}795\ \ state\ \ commercial\ \ units} \right)$$

$$Annual\ VOC\ Emissions = 101{,}697.5786\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 50.8488 tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor =0.00125[55]
Summer work weekday VOC emissions = 50.8488× 0.00125 = 0.0634 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{84 lbsCO \big/ MMcf}{year} \right) (148{,}346 MMcf) \left(\frac{24{,}654\ county\ commercial\ units}{197{,}795\ state\ commercial\ units} \right)$$

$$Annual\ CO\ Emissions = 1{,}553{,}199.382\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 776.5997\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00125[55]
Summer work weekday CO emissions = 776.5997× 0.00125 = 0.9683 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor =0.00478[55]
Winter work weekday CO emissions =776.5997× 0.00478 = 3.7121 tons CO per day

LPG:

Residential LPG:

$$Annual\ Emissions = (Emission\ Factor)(Residential\ LPG\ Consumption) \cdot \left(\frac{LPG - Burning\ County\ Dwelling\ Units}{LPG - Burning\ State\ Dwelling\ Units} \right)$$

where:

VOC Emission Factor = 0.5 lbs/1000 gallons/year[39]
NO_x Emission Factor = 14 lbs/1000 gallons/year[39]
CO Emission Factor = 1.9 lbs/1000 gallons/year[39]
SO_2 Emission Factor = 0.1 lbs/1000 gallons/year[39] *× 0.54 grains/100 cubic feet = 0.054 lbs/1000 gallons/year*
PM10-FIL Emission Factor = 0.4 lbs/1000 gallons/year[39]
PM25-FIL Emission Factor = 0.4 lbs/1000 gallons/year[39]
PM-CON Emission Factor = 0.506 lbs/1000 gallons/year[39]
Residential LPG Sulfur Content = 0.54 grains/100 cubic feet[27]
Residential LPG Consumption = 157,014,873.6 gallons[25 51 52]
County Dwelling Units Heating with LPG = 4317 units (Allegheny County)[7]
Commonwealth Dwelling Units Heating with LPG = 145,254 units[7]

Residential LPG Consumption Calculation: [25 51 52]

$$2002\ Residential\ LPG\ Consumption = (2001\ Residential\ LPG\ Consumption) \cdot \frac{2002\ PA\ Propane\ Consumption}{2001\ PA\ Propane\ Consumption}$$

$$= 3479.92024\ thousand\ barrels\ LPG \cdot \frac{822.8\ thousand\ gallons\ LPG\ per\ day}{765.9\ thousand\ gallons\ LPG\ per\ day}$$

$$= 3738.449\ thousand\ barrels\ LPG$$

$$3738.449\ thousand\ barrels\ LPG \cdot \frac{42\ gallons}{1\ barrel} = 157{,}014{,}873.6\ gallons\ LPG$$

Data Sources for Residential LPG Consumption Calculation:

2001 Residential LPG Consumption[25]
2002 PA Propane Consumption[51]
2001 PA Propane Consumption[43]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{0.5\ lbs VOC \Big/ 1000 gallons}{year} \right) (157{,}014{,}873.6 gallons) \left(\frac{4{,}317\ county\ dwelling\ units}{145{,}254\ county\ dwelling\ units} \right)$$

$$Annual\ VOC\ Emissions = 2333.2687\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 1.1666\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday VOC emissions = 1.1666 × 0.00275 = 0.00321 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{1.9\ lbs\ VOC \Big/ 1000\ gallons}{year} \right) (157{,}014{,}873.6\ gallons) \left(\frac{4{,}317\ county\ dwelling\ units}{145{,}254\ county\ dwelling\ units} \right)$$

$$Annual\ CO\ Emissions = 8866.4209\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 4.4332\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday CO emissions = 4.4332 × 0.00275 = 0.0122 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00275[4]
Winter work weekday CO emissions = 4.4332 × 0.00275 = 0.0122 tons CO per day

Commercial/Institutional LPG:

$$Annual\ Emissions = (EmissionFactor)(CommercialLPGConsumption)\left(\frac{CountyCommercialUnits}{StateCommercialUnits}\right)$$

where:

VOC Emission Factor = 0.5 lbs/1000 gallons/year[39]
NO_x Emission Factor = 14 lbs/1000 gallons/year[39]
CO Emission Factor = 1.9 lbs/1000 gallons/year[39]
SO_2 Emission Factor = 0.1 lbs/1000 gallons/year[39] *× 0.54 grains/100 cubic feet = 0.054 lbs/1000 gallons/year*
PM10-FIL Emission Factor = 0.4 lbs/1000 gallons/year[39]
PM25-FIL Emission Factor = 0.4 lbs/1000 gallons/year[39]
PM-CON Emission Factor = 0.506 lbs/1000 gallons/year[39]
Commercial/Institutional LPG Sulfur Content = 0.54 grains/100 cubic feet[27]
Commercial LPG Consumption = 1,380,620.1 gallons[25 51 52] (computed in the same manner as Residential LPG Consumption above)
County Commercial Facilities = 24,654 (Allegheny County)[2]
Commonwealth Commercial Facilities = 197,795 units[2]

<u>VOC Emissions</u>:

$$Annual\ VOC\ Emissions = \left(\frac{0.5\ lbs VOC / 1000\ gallons}{year}\right)(1{,}380{,}620.1\ gallons)\left(\frac{24{,}654\ county\ commercial\ units}{197{,}795\ state\ commercial\ units}\right)$$

$$Annual\ VOC\ Emissions = 86.0431\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 0.0430\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday VOC emissions = 0.0430× 0.0028 = 0.000122 tons VOC per day

<u>CO Emissions</u>:

$$Annual\ CO\ Emissions = \left(\frac{1.9\ lbs CO / 1000\ gallons}{year}\right)(1{,}380{,}620.1\ gallons)\left(\frac{24{,}654\ county\ commercial\ units}{197{,}795\ state\ commercial\ units}\right)$$

$$Annual\ CO\ Emissions = 326.9640\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 0.1635\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.0028[4]
Summer work weekday CO emissions = 0.1635 × 0.0028 = 0.000462 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.0028[4]

Winter work weekday CO emissions = 0.1635 × 0.0028 = 0.000462 tons CO per day

OPEN BURNING (5 SCCs)

(Residential Municipal Solid Waste Open Burning SCC 2610030000; Residential Leaf Open Burning SCC 2610000100; Residential Brush Open Burning SCC 2610000400; Commercial/Institutional Open Burning SCC 2610020000, Industrial Open Burning SCC 2610010000)

Open burning can be done in open drums or baskets, in fields and yards, and in large open dumps or pits. Materials commonly disposed of in this manner include municipal waste, auto body components, landscape refuse, agricultural field refuse, wood refuse, bulky industrial refuse, and leaves. For emission inventory purposes, Open Burning is divided into five categories: Residential Municipal Solid Waste (MSW); Residential Leaf; Residential Brush; Commercial/Institutional; and Industrial.

Criteria pollutant annual emissions associated with three of the Residential Open Burning categories (i.e., MSW, Leaf, and Brush) were compiled from an inventory prepared for the Mid-Atlantic/Northeast Visibility Union (MANE-VU).[56] Because the MANE-VU estimates were prepared at the Census tract level, it was necessary to aggregate these estimates to the county-level. In many cases, it was necessary to develop a county-level RP value by weighting MANE-VU inventory Census tract level RP values by Census tract emissions. Seasonal emission estimates were calculated from the annual estimates using the temporal allocation profiles developed in the MANE-VU inventory project.

Annual emission estimates for Commercial/Institutional and Industrial Open Burning were calculated in this project using AP-42 emission factors and population and employment based emission activity loading factors.[16 39] U.S. Census Bureau population data were used in the Residential and Commercial/Institutional calculations, while the number of Manufacturing employees (NAICS 31-33) was used for the Industrial category. The 2001 Manufacturing sector employment data from County Business Patterns[2] was grown to 2002 using the ratio of the 2002 Pennsylvania Manufacturing sector employment to the 2001 Pennsylvania Manufacturing sector employment obtained from the Bureau of Labor Statistics.[3] Seasonal Commercial/Institutional and Industrial emission estimates were developed by applying temporal allocation profiles from EPA's EMCH to the annual emission estimates.[4] Commercial/Institutional and Industrial Open Burning are prohibited in the Commonwealth. An 80 percent RE value was applied to each county's Commercial/Institutional and Industrial emissions to reflect less than 100 percent compliance with the burning ban.[57] For the Industrial and Commercial sector source categories, point source emissions, where present, were subtracted from these emission estimates.

The following provides samples of the emission calculations performed in this effort for each of the five open burning categories.

SAMPLE CALCULATIONS:

Residential MSW Open Burning:

(See MANE-VU inventory report for discussion of annual emission calculations)[56]

Annual VOC emissions (Allegheny County) = 0.3823 tons VOC per year
Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0021[56]
Summer work weekday VOC emissions = 0.3823× 0.0021 = 0.0008 tons VOC per day

Annual PM10-PRI emissions (Allegheny County) = 1.6979 tons VOC per year
Winter work weekday PM10-PRI emissions = annual PM10-PRI emissions× winter work weekday allocation factor
Winter work weekday allocation factor = 0.0021[56]
Winter work weekday PM10-PRI emissions = 1.6979 × 0.0021 = 7.2489 tons VOC per day

Residential Leaf Open Burning:

(See MANE-VU inventory report for discussion of annual emission calculations)[56]

Because the summer and winter season work weekday allocation factors for leaf burning are 0, summer season work weekday and winter season work weekday emissions are 0.

Residential Brush Open Burning:

(See MANE-VU inventory report for discussion of annual emission calculations)[56]

Annual VOC emissions (Allegheny County) = 0.2263 tons VOC per year
Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.0005[56]
Summer work weekday VOC emissions = 0.2263× 0.0005 = 0.0001 tons VOC per day

Annual PM10-PRI emissions (Allegheny County) = 0.235 tons VOC per year
Winter work weekday PM10-PRI emissions = annual PM10-PRI emissions× winter work weekday allocation factor
Winter work weekday allocation factor = 0.0017[56]
Winter work weekday PM10-PRI emissions = 0.235 × 0.0017 = 0.00004 tons VOC per day

Commercial/Institutional Open Burning:

$$Annual\ \ Emissions = (EmissionFactor)(LoadingFactor)(Population)\left(1-\frac{CE}{100}\cdot\frac{RP}{100}\cdot\frac{RE}{100}\right)$$

where:

VOC Emission Factor = 30 lbs VOC/ton waste/year[39]

NO_x Emission Factor = 6 lbs NO_x/ton waste/year[39]
CO Emission Factor = 85 lbs CO/ton waste/year[39]
Loading Factor = 24 tons waste/1000 people[39]
Population = 94,437 people (Adams County – this is non-air basin county)[7]
CE (Control Efficiency) = 100%[57]
RP (Rule Penetration) = 100%
RE (Rule Effectiveness) = 80%[57]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{30\ lbs\ VOC \big/ ton\ waste}{year} \right) \left(\frac{24\ tons\ waste}{1000\ people} \right) (94{,}437\ people) \left(1 - \frac{100}{100} \cdot \frac{100}{100} \cdot \frac{80}{100} \right)$$

$$Annual\ VOC\ Emissions = 13{,}598.928\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 6.7995\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday VOC emissions = 6.7995× 0.00275 = 0.0187 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{85\ lbs\ CO \big/ ton\ waste}{year} \right) \left(\frac{24\ tons\ waste}{1000\ people} \right) (94{,}437\ people) \left(1 - \frac{100}{100} \cdot \frac{100}{100} \cdot \frac{80}{100} \right)$$

$$Annual\ CO\ Emissions = 38{,}530.296\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 19.2651\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday CO emissions =19.2651× 0.00275 = 0.0530 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00275[4]
Winter work weekday CO emissions = 19.2651 × 0.00275 = 0.0530 tons CO per day

Industrial Open Burning:

$$Annual\ Emissions = (Emission Factor)(Loading Factor)(Employees) \left(1 - \frac{CE}{100} \cdot \frac{RP}{100} \cdot \frac{RE}{100} \right)$$

where:

Emission Factors are the same as for Commercial/Institutional Open Burning
Loading Factor = 160 tons waste/1000 employees[39]

Employees = 8,216 employees (Adams County – this is non-air basin county) [2] [3]
Control Efficiency = 100%[57]
Rule Penetration = 100%
Rule Effectiveness = 80%[57]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{30\ lbs\ VOC \big/ ton\ waste}{year} \right) \left(\frac{160\ tons\ waste}{1000\ employees} \right) (8216\ employees) \left(1 - \frac{100}{100} \cdot \frac{100}{100} \cdot \frac{80}{100} \right)$$

$$Annual\ VOC\ Emissions = 7887.36\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 3.9437\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday VOC emissions = 3.9437 × 0.00275 = 0.0108 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{85\ lbs\ CO \big/ ton\ waste}{year} \right) \left(\frac{160\ tons\ waste}{1000\ employees} \right) (8216\ \ employees) \left(1 - \frac{100}{100} \cdot \frac{100}{100} \cdot \frac{80}{100} \right)$$

$$Annual\ CO\ Emissions = 22{,}347.52\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 11.1738\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday CO emissions =11.1738 × 0.00275 = 0.0307 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00275[4]
Winter work weekday CO emissions = 11.1738 × 0.00275 = 0.0307 tons CO per day

OTHER SPECIAL PURPOSE COATING (SCC 2401200000)

This category includes special purpose coatings used for applications such as maintenance operations at industrial and other facilities, auto refinishing, traffic paints, marine finishes, and aerosol sprays. Note that this category covers those specific coating processes not already included in other source categories (e.g., High Performance Industrial Maintenance Coatings). Emissions for this category were estimated using a per capita emission factor and U.S. Bureau of the Census population data. Each county's emissions were calculated per the following sample calculations.

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\ VOC\ Emissions = (Emission\ Factor)(Population)\left(1 - \frac{CE}{100} \cdot \frac{RP}{100} \cdot \frac{RE}{100}\right)$$

where:

VOC Emission Factor = 0.8 lbs VOC/person/year[16]
Population = 1,269,904 (Allegheny County)[7]
Control Efficiency = 20% [5]
Rule Penetration = 100%
Rule Effectiveness = 100%

$$Annual\ VOC\ Emissions = \left(\frac{0.8\ lbs\ VOC \Big/ person}{year}\right)(1{,}269{,}904\ people)\left(1 - \frac{20}{100} \cdot \frac{100}{100} \cdot \frac{100}{100}\right)$$

$$Annual\ VOC\ Emissions = 812{,}738.56\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 406.3693\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00356 [9]
Summer work weekday VOC emissions = 406.3693 × 0.00356 = 1.4473 tons VOC per day

OTHER TRANSPORTATION (SCC 2401085000)

This source category includes the finishing of vehicles and vehicle parts not included in other source categories (note that area source emissions were not estimated for the Motor Vehicle Surface Coating category because all Pennsylvania automobile assembly plants are assumed to be included in the point source inventory). The emissions for each county were calculated per the sample calculations below using an employment-based emission factor and employee data from NAICS Codes 33633, 33634, 33635, 333924, 336312, 336322, 336399, 336411, 336413, and 33651. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio or 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics.[3] Point source emissions, where present, were subtracted from these emission estimates. Note that emissions for this category are reported using the Railroad SCC because there is no "Other Transportation" SCC.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Number of Employees)

where:

VOC Emission Factor = 35 lbs VOC/employee/year[16]
Employees = 2556 employees (Allegheny County)[2] [3]

$$Annual\ VOC\ Emissions = \left(\frac{35\ lbs\ VOC \big/ employee}{year} \right) (2556\ employees)$$

$$Annual\ VOC\ Emissions = 89{,}460\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 44.73\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00287 [4]
Summer work weekday VOC emissions = 44.73 × 0.00287 = 0.1282 tons VOC per day

PESTICIDE APPLICATION (SCC 2461800000)

Pesticides, which contain petroleum solvents and synthetic organic ingredients, are used to kill or retard the growth of insects, rodents, fungi, weeds, or microorganisms. The bulk of pesticide application is associated with agriculture and, therefore, occurs in rural areas. The VOC emissions for each county were estimated using an emission factor based on the number of harvested acres. Harvested acreage data were obtained from the U.S. Department of Agriculture's National Agricultural Statistics Service.[58]

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (Emission Factor)(Acres Harvested)

where:

VOC Emission Factor = 3.5 lbs VOC /acre harvested/year[16]
Acres Harvested = 10,527.2490 acres harvested (Allegheny County)[58]

$$Annual\ VOC\ Emissions = \left(\frac{3.5\ lbs\ VOC \big/ acres\ harvested}{year} \right) (10{,}527.2490\ acres\ harvested)$$

$$Annual\ VOC\ Emissions = 36{,}845.3716\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 18.4227\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00277[4]
Summer work weekday VOC emissions = 18.4227× 0.00277 = 0.0510 tons VOC per day

PORTABLE GASOLINE CONTAINERS (SCC 2501060300)

This category covers emissions from residential and commercial sector portable gasoline containers. This category accounts for permeation, diurnal, transport, spillage, and vapor

displacement emissions. Permeation, diurnal, and transport emissions are based on daily gasoline container throughput data. Gasoline throughput for 2002 was estimated based on gas container population and use data obtained from a California Air Resources Board survey.[59] The year 2002 residential container population was estimated from the county-level number of occupied housing units.[60] For counties for which 2002 occupied housing units data were not available, 2000 year housing units data[61] were projected to 2002 based on county population growth rates.[7] The year 2002 commercial container population was estimated from the number of commercial sector businesses.[62] County-level nonroad equipment gasoline consumption estimates were obtained from the NONROAD model.[63]

County-level year 2002 housing unit, commercial facility, and gasoline throughput data were then used in the emission calculation procedures described in *Control Measure Development Support Analysis of Ozone Transport Commission Model Rules*.[9] For the permeation, diurnal, and transport emission processes, these procedures result in daily emission estimates for both residential and commercial. These emissions were converted to annual emissions by multiplying by 214 days based on the assumption that nonroad equipment is fueled via gas containers primarily between April and October. The resulting annual emission estimates were then added to the spillage and vapor displacement annual emissions estimates, which were developed from annual NONROAD model gasoline consumption data, to yield total portable gasoline container annual emissions for each county. Summer season work weekday allocation factors were developed from the NONROAD model temporal allocations and applied to the annual emissions estimates to obtain summer season workday emissions.[63]

SAMPLE VOC EMISSION CALCULATION:

For Allegheny County:

$$\textit{Annual Permeation, Diurnal, and Transport VOC Emissions} = \sum \textit{Daily Emissions} \times 214 \textit{ days}$$

where (calculated using Ozone Transport Commission methods):

Allegheny Residential Permeation VOC Emissions = 299,065.1043 g/day
Allegheny Residential Diurnal VOC Emissions = 2,582,567.049 g/day
Allegheny Residential Transport VOC Emissions = 141,733.9079 g/day
Allegheny Commercial Permeation VOC Emissions = 41,816.3711 g/day
Allegheny Commercial Diurnal VOC Emissions = 408,285.9064 g/day
Allegheny Commercial Transport VOC Emissions = 255,584.0428 g/day

Annual Permeation, Diurnal, and Transport VOC Emissions = 3,729,052.382 g/day × 214
Annual Permeation, Diurnal, and Transport VOC Emissions = 798,017,209.6 *g/year*

Total Annual Emissions = Annual Permeation, Diurnal, and Transport Emissions + Annual Spillage Emissions + Annual Vapor Displacement Emissions

where:

Spillage VOC Emissions = 307,338,392.7 g/year
Vapor Displacement VOC Emissions = 93,509,532.4 g/year

Total Annual Emissions = 798,017,209.6 *g/year* + 307,338,392.7 *g/year* + 93,509,532.4 *g/year*

$$\textit{Total Annual Emissions} = 1{,}198{,}865{,}134.7\ \textit{g/year} \times \frac{1\ \textit{ton}}{907{,}184.74\ \textit{g}}$$

= 1,321.5226 tons/year

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month proportion× weekday ratio/number of weekdays in summer
Summer work weekday allocation factor = 0.3600× 0.692/65 = 0.00383 [63]
Summer work weekday VOC emissions = 1321.5226× 0.00383 = 5.0639 tons VOC per day

REFRIGERANT LOSSES (SCC 2399010000)

This source category covers industrial refrigerant losses from refrigeration equipment used in such industries as ice cream manufacturing, meat packing plants, ice manufacturing, and refrigerated warehousing. Losses occur in both the normal use of refrigeration systems and during malfunctions. Emissions for each county were estimated using an employment-based emission factor[64,65] and the number of employees in the following NAICS codes: 311611, 311612, 311613, 311615, 311512-311514, 31152, 311411, 311412, 311421-311423, 31181, 31132, 31133, 31211-31213, 31171, 312113, 311991, 311999, 325211, 49312, 311612, 42281, 42282. The number of employees in each county was obtained from *County Business Patterns*[66] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the Bureau of Labor Statistics (BLS). Each county's emissions were estimated per the sample calculations below.

SAMPLE NH_3 EMISSION CALCULATION:
Annual NH_3 Emissions = (Emission Factor)(Number of Employees in Sector)

Where:
Emission Factor = 30 lbs NH_3/ employee/ year
Employees = 8265 (Allegheny County)

$$\textit{Annual } NH3 \textit{ Eissions} \equiv \left[\frac{30\ \textit{lbs } NH3/\textit{employee}}{\textit{year}}\right](8265\ \textit{employees})$$

$$\textit{Annual } NH_3 \textit{ Emissions} = 247{,}950 \text{ pounds } NH_3 \text{ per year} * \frac{1\ \textit{ton}}{2000\ \textit{lbs}} = 123.975 \text{ tons } NH_3/\text{ year}$$

PUBLIC OWNED TREATMENT WORKS (3 SCCs)

Public Owned Treatment Works (POTWs) are wastewater treatment plants typically owned by municipalities. Emissions are calculated for three POTW processes: POTW Wastewater Treatment Processes (SCC 2630020010), POTW Biosolids Processes (SCC 2630020020), and Biosolids Land Application (SCC 2630050000). Biosolids are recyclable solid, semisolid, or liquid untreated residue from sewage treatment in a wastewater treatment plant.

Although both VOC and NH_3 emissions result from each of the three processes included in this category, VOC emissions are only estimated for POTW Wastewater Treatment Processes (SCC 2630020010) because of the lack of VOC emission factors for the other processes. Annual NH_3 emission estimates were taken from an on-going Mid-Atlantic/Northeast Visibility Union (MANE-VU) inventory development project. As part of this Pennsylvania inventory effort, annual VOC emissions were estimated for the POTW Wastewater Treatment Processes category using the MANE-VU project Pennsylvania emission activity data (total POTW flow) and an AP-42 sewage treatment emission factor.[28] Summer season work weekday emissions were calculated for each process using a summer season work weekday allocation factor based on EIIP temporal allocation guidance.[1]

Year 2000 POTW flow data for Pennsylvania facilities were obtained from the EPA Office of Wastewater Management's year 2000 Clean Watersheds Needs Survey.[67] Year 2002 wastewater flow was estimated from the county population change between 2000 and 2002.[7] Year 2000 statewide biosolids generation was obtained from BioCycle 2000.[68] Facility-level biosolids production was estimated based on allocating State generation using facility-level wastewater flow rates. Year 2002 biosolids generation was estimated by applying Bureau of Census county population growth rates to year 2000 generation.[7] Land application of total biosolids generation was calculated by multiplying total generation by 55 percent, which represents the percentage of total Pennsylvania biosolids generation applied to land.[68] Further information on the annual emission estimation methods for the processes in this category will be available in a forthcoming report prepared for MANE-VU. Where present, point source emissions were subtracted from the emissions of the corresponding county. Each county's emissions were calculated per the following sample calculations.

SAMPLE VOC CALCULATIONS:

$$Annual\ VOC\ Emissions = (EmissionFactor)(County\,Wastewater\,Flow)$$

where:

Emission Factor = 8.9 lbs VOC/millions of gallons flow
Flow = 75,290.54 million gallons (Allegheny County)

$$Annual\ VOC\ Emissions = \left(\frac{8.9\ lbs\,VOC \Big/ million\ gallons}{year} \right)(75{,}290.54\ E6\ gallons) = 670{,}085.81\ lbs$$

$$Annual\ VOC\ Emissions = 670{,}085.81\ lbs\left(\frac{1\ ton}{2000\ lbs} \right) = 335.04\ tons\ VOC$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor

Summer work weekday allocation factor = 0.00385[1]
Summer work weekday VOC emissions = 335.04 × 0.00385 = 1.2899 tons VOC per day

SAMPLE NH_3 CALCULATION:

$$Annual\ NH3\ Emissions = (G\ x\ EF_{NH3}) / 2000$$

Where:

G = Annual amount of wastewater processed (MMgal) = 75,290 (Allegheny Co.)
EF_{NH3} = Ammonia emission factor of 0.027 lb/ MMgal (Pechan, 2004a)[64]

$$Annual\ NH_3\ Emissions = (75{,}290\ MMgal\ x\ 0.027\ lb\ NH3) / 2000 = 1.016415\ Tons\ NH_3$$

RESIDENTIAL WOOD COMBUSTION (7 SCCs)

(Fireplaces: Without Inserts SCC 2104008001; Fireplaces: Inserts - Catalytic, non-EPA-certified SCC 2104008002; Fireplaces: Inserts - Non-catalytic, EPA-certified SCC 2104008003; Fireplaces: Inserts - Catalytic, EPA-certified SCC 2104008004; Woodstoves - Conventional SCC 2104008010; Woodstoves - Catalytic SCC 2104008030; and Woodstoves - Non-catalytic SCC 2104008050)

Criteria pollutant annual emissions associated with residential heating with wood were compiled from the 2002 nonpoint source National Emissions Inventory (NEI).[31] The 2002 NEI reports residential wood combustion emissions in seven SCCs, each of which representing a specific combustion equipment type. The NEI reports emissions for the following criteria pollutants: VOC, NO_x, CO, SO_2, PM10-PRI, and PM25-PRI. The NEI residential wood combustion emission estimation methodology is based on the national population of each equipment type and an estimate of the amount of wood burned in each type of equipment. The national wood combustion estimates by equipment type were then allocated to counties using a number of steps. These steps incorporated information on heating degree days by climate zone, and the urban/rural designation and number of single-family detached homes in each county. Further details on the annual emission estimation methodology are available in a forthcoming 2002 nonpoint source NEI document. [31]

The majority of the residential wood combustion emission factors were obtained from EPA's AP-42 document.[39] County-level seasonal throughput percentages developed for the 2002 NEI were applied in this effort to estimate winter season work weekday emissions (no residential wood combustion activity was allocated to summer season months).

SAMPLE SEASONAL CALCULATION (FIREPLACES WITHOUT INSERTS):

Annual PM10-PRI emissions (Allegheny County) = 59.8205 tons VOC per year
Winter work weekday PM10-PRI emissions = annual PM10-PRI emissions× winter work weekday allocation factor
Winter work weekday allocation factor = 0.0044

Winter work weekday VOC emissions = 59.8205 × 0.0044 = 0.2632 tons VOC per day

SOLID WASTE INCINERATION (2 SCCs)

(Commercial/Institutional Solid Waste Incineration SCC 2601020000, Industrial Solid Waste Incineration SCC 2601010000)

Solid waste may consist of any discarded solid materials from commercial or industrial sources. The materials may be combustible or noncombustible, and are often burned to reduce bulk, unless direct burial is either available or practical. The resulting pollutants for the purpose of this inventory are VOC, NO_x, and CO. On-site incineration is the confined burning of waste leaves, landscape refuse, or other refuse or rubbish. Slash and large scale agricultural open burning are not included in this emission category.

The emissions for each county were estimated per the sample calculations below using emission factors and loading factors from AP-42, population data from the U.S. Census Bureau, and employee data from *County Business Patterns*. Point source emissions, where present, were subtracted from these emission estimates.

SAMPLE CALCULATIONS:

Commercial/Institutional Solid Waste Incineration:

Annual Emissions = (Emission Factor)(Loading Factor)(Population)

where:

VOC Emission Factor = 9.8 lbs VOC/ton waste burned/year[39]
NO_x Emission Factor = 3.7 lbs NO_x/ton waste burned/year[39]
CO Emission Factor = 37 lbs CO/ton waste burned/year[39]
Loading Factor = 54 tons/1000 people[39]
Population = 1,269,904 people (Allegheny County)[7]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{9.8 lbs VOC \,/\, ton\ waste\ burned}{year} \right) \left(\frac{54\ tons\ waste}{1000\ people} \right) (1{,}269{,}904\ people)$$

$$Annual\ VOC\ Emissions = 672{,}033.1968\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 336.0166\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday VOC emissions = 336.0166× 0.00275 = 0.9240 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{37\ lbs\ CO \Big/ ton\ waste\ burned}{year} \right) \left(\frac{54\ tons\ waste}{1000\ people} \right) (1{,}269{,}904\ \ people)$$

$$Annual\ CO\ Emissions = 2{,}537{,}268.192\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 1268.6341\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday CO emissions =1268.6341× 0.00275 = 3.4887 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00275[4]
Winter work weekday CO emissions = 1268.6341× 0.00275 = 3.4887 tons CO per day

Industrial Solid Waste Incineration:

Annual VOC Emissions = (Emission Factor)(Loading Factor)(Number of Employees)

where:

Emission Factors are the same as noted above
Loading Factor = 560 tons/1000 employees[39]
Employees = 48,544 employees (Allegheny County)[2 3]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{9.8\ lbs\ VOC \Big/ ton\ waste\ burned}{year} \right) \left(\frac{560\ \ tons\ waste\ burned}{1000\ employees} \right) (48{,}544\ employees)$$

$$Annual VOC\ Emissions = 266{,}409.472\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 133.2047\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday VOC emissions = 133.2047× 0.00275 = 0.3663 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{37\ lbs\ CO \Big/ ton\ waste\ burned}{year} \right) \left(\frac{560\ tons\ waste\ burned}{1000\ employees} \right) (48{,}544\ employees)$$

$$Annual\ CO\ Emissions = 1{,}005{,}831.68\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 502.9158\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00275[4]
Summer work weekday CO emissions =502.9158× 0.00275 = 1.3830 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.00275[4]
Winter work weekday CO emissions = 502.9158× 0.00275 = 1.3830 tons CO per day

STRUCTURE FIRES (SCC 2810030000)

Building fires can produce short-term emissions of VOC, NO_x, CO, and PM. Structure fire emissions were estimated using emission factors, a loading factor, and a default number of fires per capita (note that PM10-FIL, PM25-FIL, and PM-CON emission factors were not available). Population data were obtained from the U.S. Census Bureau. Each county's emissions were calculated per the following sample calculations.

Annual Emissions = (Emission Factor)(Loading Factor)(Per Capita # of Fires)(Population)

where:

VOC Emission Factor = 11 lbs VOC/ton material burned/year[16]
NO_x Emission Factor = 1.4 lbs NO_x/ton material burned/year[16]
CO Emission Factor = 60 lbs CO/ton material burned/year[16]
Loading Factor = 1.15 tons material/fire[69]
Per Capita Number of Fires = 0.0018 fires/person[70]
Population = 1,269,904 (Allegheny County)[7]

VOC Emissions:

$$Annual\ VOC\ Emissions = \left(\frac{11\ lbs\ VOC \Big/ tons\ material}{year} \right) \left(\frac{1.15\ tons\ material}{fire} \right) \left(\frac{0.0018\ fires}{person} \right) (1{,}269{,}904\ people)$$

$$Annual\ VOC\ Emissions = 28{,}912.168\ pounds\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 14.4560\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = 0.002427[71]
Summer work weekday VOC emissions = 14.4560× 0.002427 = 0.03509 tons VOC per day

CO Emissions:

$$Annual\ CO\ Emissions = \left(\frac{60\ lbs\ CO / ton\ material}{year} \right) \left(\frac{1.15\ tons\ material}{fire} \right) \left(\frac{0.0018\ fires}{person} \right) (1{,}269{,}904\ people)$$

$$Annual\ CO\ Emissions = 157{,}702.7342\ pounds\ CO\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 78.8514\ tons\ CO\ per\ year$$

Summer work weekday CO emissions = annual CO emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.002427[71]
Summer work weekday CO emissions =78.8514× 0.002427 = 0.1914 tons CO per day

Winter work weekday CO emissions = annual CO emissions × winter work weekday allocation factor
Winter work weekday allocation factor = 0.003126[71]
Winter work weekday CO emissions = 78.8514× 0.003126 = 0.2465 tons CO per day

TRAFFIC LINE PAINTING (SCC 2401008000)

Traffic paints are used to mark pavement in applications such as dividing lines for traffic lanes, parking space markings, crosswalks, and arrows. The markings are usually applied by Commonwealth or local highway maintenance crews. VOC emissions result from the evaporation of organic solvents during and shortly after application of the marking paint. Each county's emissions were calculated per "Alternative Method Three" described in the EIIP emission estimation guidance document for this category.[72] The calculation uses a national per capita emission factor based on 2002 data for national traffic paint consumption and U.S. population. Control efficiency, rule penetration, and rule effectiveness factors were incorporated into the final calculation.

SAMPLE VOC EMISSION CALCULATIONS:

$$Annual\ VOC\ Emissions = (Emission\ Factor)(Per\ Capita\ Usage\ Factor)(Population) \cdot \left(1 - \frac{CE}{100} \cdot \frac{RP}{100} \cdot \frac{RE}{100}\right)$$

$$Per\ Capita\ Usage\ Factor = \frac{2002\ National\ Traffic\ Paint\ Consumption}{2002\ U.S.\ Population}$$

National per Capita Usage Factor = 39,397,000 gallons[73]*/288,368,698 people*[7]
National per Capita Usage Factor = 0.1366 gallons/person

where:

Emission Factor = 3.36 lbs VOC/gallon[72]
National per Capita Usage Factor = 0.1366 gallons/person
Population =1,269,904 (Allegheny County)[7]
CE (Control Efficiency) = 20% [5]
RP (Rule Penetration) = 100%

RE (Rule Effectiveness) = 100%

$$\text{Annual VOC Emissions} = \left(\frac{3.36 \text{ lbs VOC} / \text{gallon}}{\text{year}} \right) (0.1366 \text{ gallons/ person})(1{,}269{,}904 \text{ people}) \left(1 - \frac{20}{100} \cdot \frac{100}{100} \cdot \frac{100}{100}\right)$$

$$\text{Annual VOC Emissions} = 466{,}353.4473 \text{ pounds VOC per year} \cdot \frac{1 \text{ ton}}{2000 \text{ lbs}} = 233.1767 \text{ tons VOC per year}$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00356 [9]
Summer work weekday VOC emissions = 233.1767 × 0.00356 = 0.8305 tons VOC per day

WINERIES (SCC 2302070005)

Winery emissions result from the entrainment of ethanol by carbon dioxide during wine fermentation. Factors affecting ethanol emissions are handling techniques, temperature, process equipment design, and fermenting parameters. Other sources of emissions from the wine making process are blending, transferring, racking and storing of the wine.

Emissions were determined using 2002 county-level wine production data provided by the Pennsylvania Liquor Control Board (PLCB).[74] Because monthly production data were available, these data were used to develop the seasonal allocation factors for this category. The emission factors for both red and white wines were obtained from AP-42.[75] Since the emission factors for the two types of wines are different, but wine type production data are no longer available, wine production in the Commonwealth was assumed to be 60 percent white wine and 40 percent red wine.[76] Point source emissions, where present, were subtracted from these emission estimates. Each county's emissions were estimated per the following sample calculations.

SAMPLE VOC EMISSION CALCULATIONS:

Annual VOC Emissions = (0.6 × White Wine Emission Factor + 0.4 × Red Wine Emission Factor) × (2002 Total Wine Production)

where:

White Wine Emission Factor = 1.80873 lbs VOC/1000 gallons white wine/year[75]
Red Wine Emission Factor = 4.6236 lbs VOC/1000 gallons red wine/year[75]
2002 Total Wine Production = 8.270 thousand gallons (Adams County)[74]
2002 Summer Wine Production = 3.000 thousand gallons (Adams County)[74]
White Wine Production Factor = 60% of wine produced[76]
Red Wine Production Factor = 40% of wine produced[76]

$$Annual\ VOC\ Emissions = \left(0.6 \cdot \frac{1.80873\ lbs}{1000\ gallons} + 0.4 \cdot \frac{4.6236\ lbs}{1000\ gallons}\right)(8.270\ thousand\ gallons)$$

$$Annual\ VOC\ Emissions = 24.2698\ lbs\ VOC\ per\ year \cdot \frac{1\ ton}{2000\ lbs} = 0.0121\ tons\ VOC\ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions× summer work weekday allocation factor
Summer work weekday allocation factor = summer month wine production/annual wine production × weekday ratio/number of weekdays in summer
Summer work weekday allocation factor = 3.000/8.270× 0.715/65 = 0.00399 (Adams County)[4 74]
Summer work weekday VOC emissions = 0.0121× 0.00399 = 0.0000484 tons VOC per day

WOOD FURNITURE MANUFACTURING (SCC 2401020000)

This source category includes establishments engaged in the manufacture of wood home or office furniture. VOC emissions result from the evaporation of solvents used in the finish coats and cleanup procedures. Point source emissions, where present, were subtracted from these emission estimates. Each county's emissions were calculated according to the sample calculations below using a per employee emission factor and the number of employees in NAICS codes 337122, 337127, 337129, 337211, and 337212. The number of employees in each county for 2001 was obtained from *County Business Patterns*[2] and grown to 2002 using the ratio of 2002 total Commonwealth employees to 2001 total Commonwealth employees obtained from the *Bureau of Labor Statistics (BLS)*.[3]

A 30 percent reduction in VOC emissions was assumed based on a RACT-based regulation.[77]

SAMPLE VOC EMISSION CALCULATION:

Annual VOC Emissions = (Emission Factor)(Employees)(30% Control Efficiency Reduction)

where:

Emission Factor = 1,311 lbs VOC/employee/year[78]
Employees = 256 employees (Allegheny County)[2 3]
Control Efficiency = 30%[77]
Rule Penetration = 100%
Rule Effectiveness = 80%

$$Annual\ VOC\ Emissions = \left(\frac{1311\ \ lbs\ VOC \big/ employee}{year} \right) (256\ \ employees) \left(1 - \frac{30}{100} \cdot \frac{100}{100} \cdot \frac{80}{100} \right)$$

$$Annual\ VOC\ Emissions = 255{,}068.16\ \ pounds\ VOC\ \ per\ year \cdot \frac{1\ \ ton}{2000\ \ lbs} = 127.5341\ \ tons\ VOC\ \ per\ year$$

Summer work weekday VOC emissions = annual VOC emissions × summer work weekday allocation factor
Summer work weekday allocation factor = 0.00277[4]
Summer work weekday VOC emissions = 127.5341 × 0.00277 = 0.3539 tons VOC per day

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